INTEGRATING COMPLEX EVACUATION DYNAMICS IN RESOURCE ALLOCATION FOR RELIEF OPERATIONS

By

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ABSTRACT

The dynamic framework created as part of this research work –named the "Service Quality Response Cycle" (SQRC) Model– was formulated to understand the complex multi-factor dynamic processes evolving over time during a hurricane emergency. SQRC maps the process of interdependence between resource allocation and human service satisfaction and hypothesizes key mechanisms governing this relationship. Exogenous factors such as customer reactions to the category event; training level of response personnel; race, social stratum, home/pet ownership and education are all taken into account.

Satisfaction and demographic data was collected from victims of the 2005 Katrina Hurricane and paired with real operational data. The model was then calibrated/validated by data from the 2005 Rita Hurricane. Findings suggest that in order to maintain an acceptable level of satisfaction more attention could be given to the reduction of training time of relief workers. Variations in the system that would affect negatively the level of satisfaction are related to a reduction in the provision of meals. Financial assistance and mental health care are not sensitive to independent variation.

RESUMEN

La infraestructura dinámica creada como parte de este trabajo de investigación – denominado “Modelo de la Calidad del Servicio en el Ciclo de Respuesta” (SQRC) – fue formulado para entender el proceso dinámico de multi-factores complejos que evolucionan a través del tiempo durante una emergencia con huracán. SQRC traza un mapa del proceso de interdependencia entre la asignación del recurso y la satisfacción humana del servicio e hipotetiza los mecanismos cruciales que gobiernan esta relación. Son contemplados factores exógenos, tales como reacciones de los clientes a un suceso de esta categoría; el nivel de entrenamiento del personal de respuesta; la raza, el estrato social, ser propietario o no de casa o mascota y el nivel educativo.

Fueron recolectados datos demográficos y de satisfacción entre víctimas del Huracán Katrina del 2005 y fueron comparados con datos operacionales reales. El modelo fue luego calibrado/validado con datos del huracán Rita del 2005. Las conclusiones sugieren que para mantener un nivel aceptable de satisfacción se debería prestar más atención a la reducción en el tiempo de entrenamiento de los trabajadores dedicados a las operaciones de ayuda. Las variaciones en el sistema que afectaría negativamente el nivel de satisfacción están relacionadas con la reducción en la provisión de comidas. La asistencia financiera y los cuidados de la salud mental no son sensibles a variación independiente.

To God
To my Parents

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1 INTRODUCTION

"Success is a result, not a goal".

-- Gustave Flaubert --

This chapter introduces the foundation for this study, details the aspects that are explored in the research, and gives a view of the logical structure of the thesis.

The chapter is organized as follows: Section 1 and 2, present a brief review of the disaster relief background; Section 3, presents the research problem; Section 4, discusses the outcomes of this research work; Section 5, presents the system definitions; Section 6, describes the research questions; Section 7, shows the research objectives and Section 8, describes the subsystems definitions; Section 9, presents research contributions.

1.1 BACKGROUND

An emergency is "an event actual or imminent, which endangers or threatens to endanger life, property or the environment, and which requires a significant and coordinated response," while a disaster is defined as "a serious disruption to community life which threatens or causes death or injury to property which requires special mobilization and organizations of resources other than those normally available to those authorities" (Abrahams, 2001).

Globally, it is estimated that more than 535 thousand people were killed by natural disasters during the past decade, with more than 684 billion dollars in losses from direct damages to infrastructure and crops (International Federation of Red Cross and Red Crescent Societies, 2002). In the past two decades, every state in the union --with the exception of Alaska-- has experienced weather disasters ranging at least one billion dollars in recovery expenses (National Climatic Data Center, 2003). The long-term economic impact of these disasters, both domestically and internationally, continues to affect economies at all scales locally and globally.

Prompt and effective emergency service response to both --natural or man-made emergencies and disasters-- require information prior to, during, and after these potentially catastrophic events. This information is most needed for mitigating the societal impacts of such events.

In the event of a disaster, the government of the affected country must conduct a needs assessment to determine what emergency supplies and personnel are required. Emergency services in coordination with disaster relief organizations become an important part of this procedure because they review and approve the assistance request and coordinate supplies and personnel collected and transported to the disaster site. Effective management of relief assistance depends on anticipating and identifying problems, and on delivering specific supplies and personnel at the times and places they are needed. International disaster relief on such a large scale must be properly coordinated to avoid further chaos and confusion before, during and after the disaster. In addition, whether these needs are satisfied or not is what influence victims' perceptions of the aftermath.

Prior research has shown that the effectiveness of response efforts and the disasters' victims perceptions about such effectiveness depends largely on the quality and quantity of the training that response personnel have received, pre-outage communication and communications in the immediate aftermath with victims, the existence of a quick-response protocol and the availability of resources and equipment needed for emergency functions (Hall, 2005). Due to the wide variety of factors that influence the victims' service quality perception, once these events occur, it becomes a problem to measure the satisfaction of each one of them by means of traditional mechanisms.

Thus, identifying service characteristics that make a victim feel satisfied with the aid received becomes just an indicator that such system is working properly. However, it is not enough to determine if a disaster victim was positively impacted by the treatment given before, during and after the emergency event. This research is important for social service organizations engaged in relief since it is essential for these organizations to ascertain the right formula of resources and protocols needed for satisfying victims' immediate needs. The satisfaction of the victims and the immediate outcomes of the intervention could in turn be used to decide how to adequately allocate necessary resources at their disposal and correct any mistakes.

1.2 DISASTER PREPAREDNESS AND RELIEF SYSTEMS

Disaster relief operations are very different from the traditional war operations. In disaster relief operations everything has to go very fast, the relief workers have to leave on very short notice and cooperation with other organizations is needed in order to save as many human lives as possible. The information system of those operations has to be small, flexible, rapidly deployable and mobile (Mertens and Mees, 2006).

Human beings cannot always accurately predict the timing and location of disasters, even though technologies do exist to provide early-warning systems. Collaboration between various agencies and organizations is absolutely essential when discussing disaster planning, preparedness, and reconstruction themes. As most recent disasters have shown, it is critical that governments and civil society develop effective ways to prevent relief and optimize supply distribution systems (United Nations, 2006a).

The General Assembly of the UN has recognized that humanitarian assistance must be provided with the principles of humanity, neutrality and impartiality (United Nations, 2006b). The previous postulates are determined to establish strategies for each one of the organisms in charge of managing emergency response. Emergency response is a product of preparedness. During preparedness, participating organizations ensure the respond to an emergency in a coordinated, timely and effective manner.

There is a prescribed system of how societies respond to disasters, which often is referred to as the *emergency response cycle*. This cycle includes immediate actions following an event such as rescue and relief, as well as longer-term stages in the recovery process (Cutter, 2003). Once the event occurs, the implicated organizations can have an effective and immediate response doing rescue (hours to days) and disaster relief operations (days to weeks). Preparedness and relief both depend on having the right information at the right time (Webster, 1994). Having preparedness activities help to maximize the positive effects of disaster relief operations and minimize the negative side effects. However, an evaluation of disasters' victim's feelings or perceptions does not exist or has not been published as it relates to the emergency response cycle.

1.3 RESEARCH PROBLEM

A successful emergency-management system must be capable of demonstrating efforts to supply the necessary resources and equipment to support response operations and must accurately forecast what would be stored in advance in preparation for a potential emergency. For this reason, estimating the perceptions that evacuated victims have regarding the quality of the service received before, during and after an outage has become a priority after the last disasters that have hit the world in general, and the United States and its territories in particular. These perceptions have a tendency to change depending on evacuation patterns, work requirements, the resources available to meet those requirements, and the location of resources. Currently the relationship between the service provider's (disaster relief organizations) and the service receiver's (evacuated disaster victims') perceptions have been greatly ignored.

Actual service quality evaluation for emergency-management systems vis-à-vis the resources needed to take care of disasters' evacuated victims is not usually investigated as part of customer perceptions. For this reason, the issue of what kind of resource-allocation decisions these organizations can make or how can they improve the behavior of disaster response operations is a relevant research problem.

1.4 OUTCOMES OF THIS RESEARCH

This research develops a new model for the analysis of disaster relief operations, where service quality perception is incorporated as an evaluation process of the emergency response cycle. Here a system dynamics model is described which shows how evacuation patterns affect service delivery vis-à-vis the availability of resources. Considering that resource-allocation and quality service factors influence human perceptions and reactions before, during and after an emergency.

The factors that establish quality have many explanations. Perceived quality is taken to be a subjective measure of how the disaster victims see the service level they receive. The inconsistency between resources delivered and client's requirements and their relative levels will determine the rate at which the level of perceived quality will change. As the dynamics of the model are played out over time, the levels of resources and perceived quality may rise and fall, in turn influencing other model variables.

Further, factors such as customer reactions to the kind and category of the event; personnel's training involved in the emergency response cycle; victims' claims depending on the race, social stratum, education, affected area, etc. are usually not contemplated in the evaluation of patterns and behaviors. System dynamics can take all these into consideration.

This new model considers three aspects always present in the dynamicity of a disaster relief system: the affected community subsystem, the system capacity, and the emergency relief system performance. This research work focuses on the emergency relief system performance features (see Figure 31). The American Red Cross (ARC) provided helpful data of the Katrina and Rita relief operation related to this aspect.

Finally, this model is capable of testing how a variation in resource-allocation policies affect quality service factors presented in the emergency relief system performance that influence perceptions and reactions of the evacuated victims, before, during and after a disaster.

1.5 SYSTEM DEFINITION

A conceptual representation of the disaster relief operation was made for the purpose of comprehending all the variables and the interactions between them. This conceptual model was developed focusing on the relevant problem of the system. Figure 1 illustrates a general structure for this disaster relief operation conceptual model.

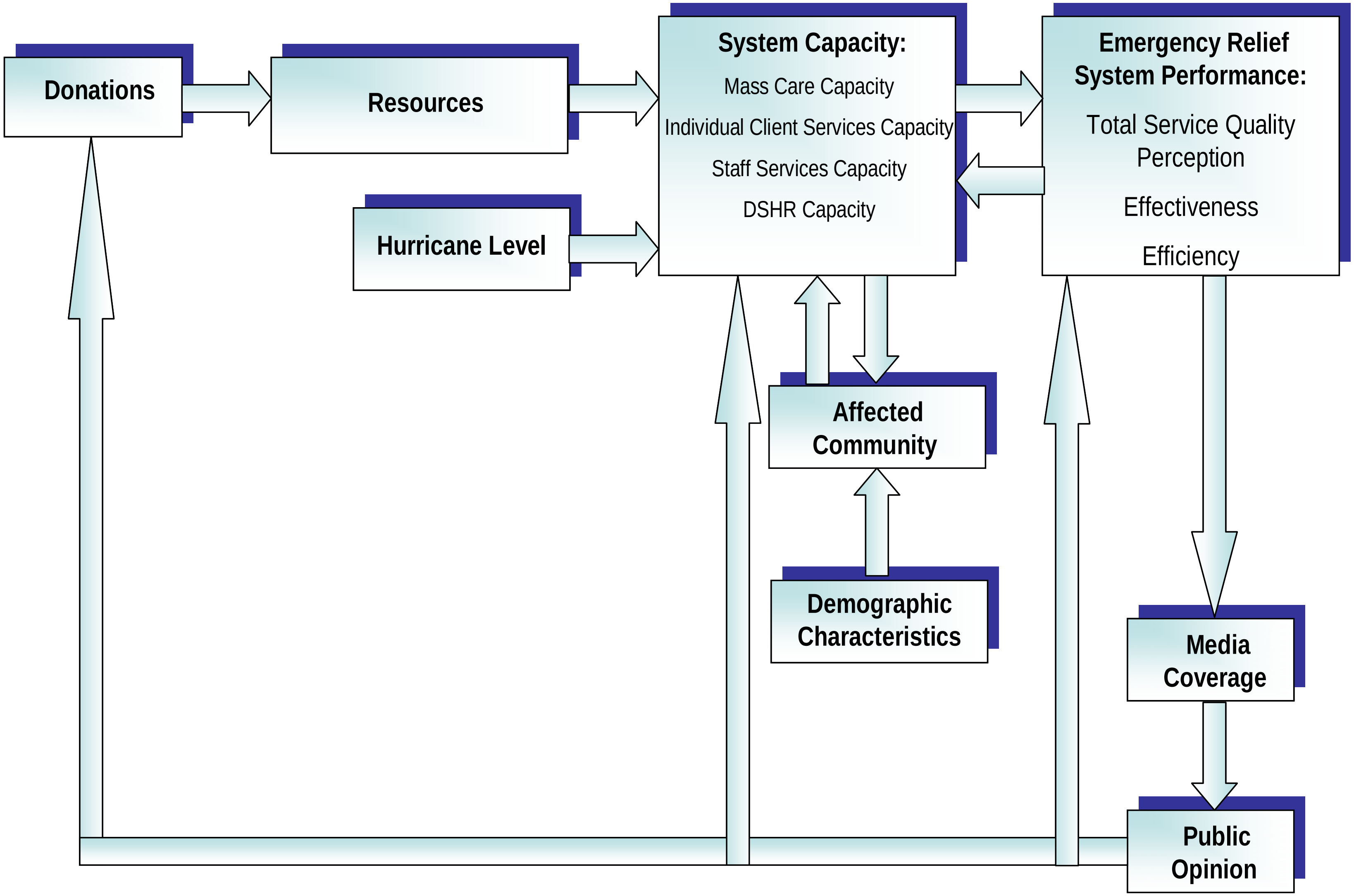


Figure 1. The conceptual model: Service Quality Response Cycle (SQRC). Author's Elaboration, 2007.

The main idea of this conceptual model is to provide a framework of knowledge of how the principal variables of the model's subsystems fit and work in relation to the outlined research problem, which is described as follows:

The total service quality perception that clients have prior to, during, and after an event occurs is affected by the capacity of the system to fulfill clients' requirements and by the public opinion. The capacity of the system is affected by the quantity of material resources needed to carry out the American Red Cross activities, the public opinion, the hurricane level and the amount of clients requiring help. The attainment of these resources depends greatly on the donations (system performance) made by non-affected communities. Hence, the affected community is influenced by the amount of resources that the relief organizations have to allocate in order to meet their needs. Therefore, the service quality perception that victims/clients demonstrate, end up influencing the media coverage, and the media coverage affects the public opinion concerning the organizations involved in the relief support and assistance to the affected community.

1.5.1 Construct Definition

A brief explanation of the role that relief operation constructs play in the dynamics of the model is explained as follows:

- Voluntary contributions -expressed in form of "***Donations***"- made to a disaster event cause is one of the ways organizations like American Red Cross (ARC) capture financial resources. This is made with the aim to increase the supplied "***Resources***" needed to mitigate the impact that a disaster has on the community.

- Then the quantity of these resources establishes what will be the capacity of the system that the American Red Cross has for the purpose of accomplishing and supporting the major activities of the relief system. It means that "***Resources***" influence "***System Capacity***" expressed as: Mass Care Capacity, Individual Client Services Capacity, Staff Services Capacity and DSHR Capacity.

- The greater the Hurricane Level, the greater the amount of resources that need to be deployed by the relief organization. Then, "***Hurricane Level***" influences "***System Capacity***".

- With the right amount of resources established as part of the System's Capacity, for each one of the group activity functions, it is possible to bring an acceptable service quality level to the affected community. Once a service is received the clients respond to it, which is, by means of the evaluation of the effectiveness, efficiency, and the quality of service provided by the involved organizations. The above demonstrates the influence that "***System Capacity***" has on the "***Emergency Relief System Performance***" and provides for an effective and efficient service.

- In addition, the quantity of the resources that the American Red Cross needs to store in order to perform and facilitate the relief operation, affects the capacity of the system. It means that "***Emergency Relief System Performance***" influence "***System Capacity***".

- "***Demographic Characteristics***" involves social class bands, which influences the "***Affected Community***".

- The amount of resources deployed is determined for the number of people affected by the disaster. Therefore, "***Affected Community***" influences the "***System Capacity***".

- The amount of resources allocated to meet the clients' needs is determined by the capacity of the system. Hence, "***System Capacity***" influences the "***Affected Community***".

- The American Red Cross is exposed to extensive media coverage of those episodes related to the disaster relief operation. This high degree of exposure is important, as the media is the source of information acquisition that people use in order to form their opinions of the world around them. Likewise, the perception of the affected people, concerning the quality of service received in cases of a disaster event, becomes the source of news for the media, and it is used to present the reality of a community hit by a catastrophe. Hence, in cases of disaster, it is the "***Emergency Relief System Performance***" what influences "***Media Coverage***" of the aftermath.

- Therefore, "***Media Coverage***" affects the "***Public Opinion***" a client has of the organizations involved in the relief operation.

- Public Opinion influences the amount of volunteers the relief organization can recruit. Therefore, "***Public Opinion***" affects the "***System Capacity***"***.***

- Finally, changes in "***Public Opinion***" affect "***Donations***".

1.5.2 Use of Service Quality Response Cycle (SQRC)

The Service Quality Response Cycle (SQRC) is the proposed system dynamics framework model which allowed the understanding of complex interrelationships existing between different elements within the disaster relief operation system (see chapter 3).

This model will be used to demonstrate: What is the effect of resource allocation on the timeliness and quality of the completed disaster relief operation at its beginning, and how this distribution can result in snowballing or diminishing needs for resources in the final stages of relief activities. Then the SQRC model contemplates biases towards allocation of resources to relief procedures, which is an important concern, since it can lead to systematic under or over allocation in the early phases of the process. This can be crucial to the establishment of success or failure of the disaster relief operation, and consequently client satisfaction.

This research also focuses on the affected community's impression of the service provided by the American Red Cross, and how these perceptions can impact the whole system. The focus of the research is on the answers given by clients that were collected in surveys during and after the Katrina and Rita Hurricanes. All the information that it can be accessed in the real world (found in American Red Cross databases) can be used for model evaluation. This research is specifically intended for this agency which leads in mass care activities and provides human services.

Analyzing the model diagram, it can be seen that it is simple enough to be easily explained and understood at the managerial level of disaster relief services, and specific enough that the activities can be carried out concerning Mass Care, Individual Client Services and Staff Services of the American Red Cross.

1.6 RESEARCH QUESTIONS

Q1: What is the right amount of resources needed to be allocated by relief organizations during a Hurricane disaster in order to have a positive influence on the evacuated clients' perceptions of the quality of the services received during disaster?

Q2: What relationships among organizational and environmental factors are needed in order to be considered into system dynamics for the disaster relief service's resource allocation problem? What are the external factors that define an evacuation decision profile for the affected clients'?

Q3: How do the evacuated clients' perceptions of service quality during a natural disaster, paired with the clients' characteristics, affect the allocation of resources needed by the implicated organizations? This last question is the main premise of this thesis; the way client's perceptions of service quality affect allocation of resources, and vice versa, are the questions that are going to be tested during this simulation.

1.7 RESEARCH OBJECTIVES

To answer the above questions, the following research objectives were pursued:

O1: To develop a conceptual model of service quality for the emergency management systems and emergency service's resource allocation concentrated in the disaster relief area and for hurricane events.

O2: To operationalize the conceptual model developed in O1. This model is specific to American Red Cross Organization and is operationalized by identifying key observed variables.

O3: To build a system dynamics model of the above mentioned operational model that provides an understanding of the current state of a disaster relief system being modeled given the environmental characteristics of the affected community and to indicate the course for better resource allocation.

O4: To establish the relationships among environmental community factors and the predisposition to evacuate.

O5: To validate the model applying the above results to a real organization using data obtained and facilitated by the American Red Cross of pre and post Katrina and Rita Hurricanes disasters.

1.8 SUBSYSTEMS DEFINITION

Various subsystems are contained within the structure of the model and represent several functions. Mapping these subsystems and illustrating their relationship using a diagram can facilitate the comprehension of the model.

Figure 2 shows the graphical representation of the general structure of the disaster relief operation conceptual model and its subsystems. The main idea of these subsystems is to group the independent but interrelated variables and constructs of the system dynamic model.

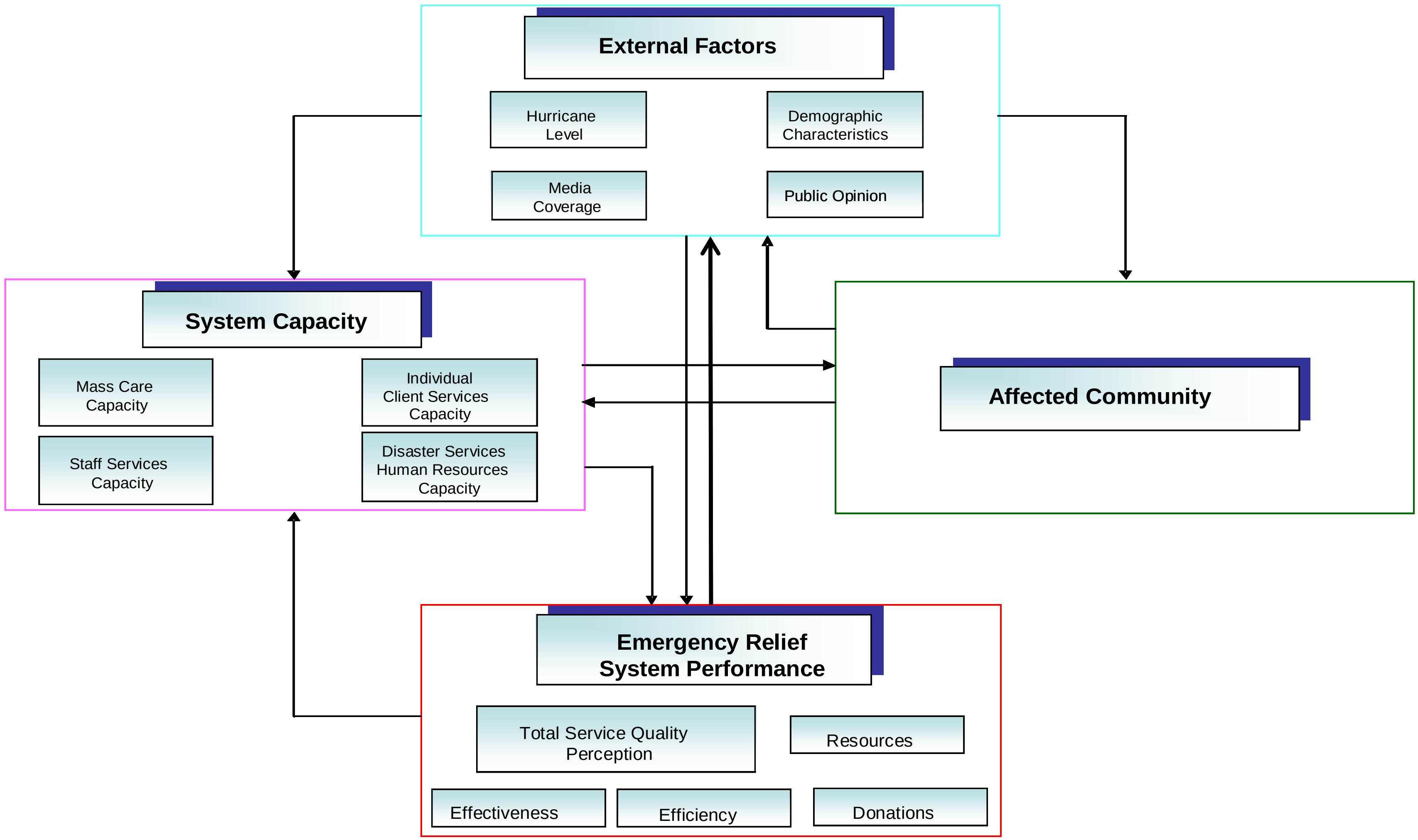


Figure 2. The conceptual model: Service Quality Response Cycle (SQRC) and its Subsystems. Author's Elaboration, 2007.

The combination of the variables in the conceptual model and the representation of the reciprocal influences have allowed the identification of three interconnected subsystems which represent its core functions: System Capacity, Emergency Relief System Performance and Affected Community.

A general definition of assumed relationships is described as follows:

The amount of resources needed for mass care to carry out relief operation activities is determined by the quantity of clients affected by the disaster. System Capacity also influences the affected community subsystem. Likewise the system performance influences the quantity of resources required in the activities of the American Red Cross group/activity function. The system's performance embraces constructs, such as, service quality, effectiveness and efficiency that influence the perceptions of the community affected by a disaster event. Therefore, system capacity, emergency relief system performance and affected community, are also influenced by external factors. Finally External Factors are influenced by the affected community subsystem, and the emergency relief system performance.

A description of each one of these subsystems is provided as follows:

A. **Affected Community Subsystem:** This subsystem explains important factors that could change the lives of current and future residents, in case of an emergency.

- The quantity of resources required by disaster relief organizations, with the aim of meeting the client's needs, is a critical part of the assessment and should contribute to any decision of future resource allocation of these organizations to improve its operations. Therefore, "***System Capacity***" influences "**Affected Community Subsystem**" and vice versa.

- As a matter of fact, expanding a comprehension of community concerns is an important first step in conducting a service quality impact assessment. Hence, "**Affected Community Subsystem**" influences "***External Factors***".

- Demographic characteristics constitute an important factor for the establishment of the victim's profile for evacuation decision before, after or during a disaster hits. Therefore, "***External Factors***" influences "**Affected Community Subsystem**" and vice versa (see Figure 2).

B. **System Capacity:** This subsystem represents the amount of disaster human resources and material resources employed along the entire disaster relief operation.

- It is composed of three group/activity functions of the American Red Cross: "***Mass Care Capacity***", "***Individual Client Services Capacity***" and "***Staff Services Capacity***". It also includes any Red Cross unit employee or volunteer ("***DSHR Capacity***") who has identified the competencies to assume the responsibility to carry out an identified activity in support of a disaster response. Therefore, "***System Capacity***" influences "***Affected Community Subsystem***".

- The people affected by the disaster receive help in form of shelter and feeding which is called mass care function, and financial assistance which is called individual client services function. Then, "***Affected Community Subsystem***" affects "***System Capacity***".

- The cases opened through the casework process and the amount of financial assistance provided to the disaster victims, in form of client assistance cards, is an Individual Client Service function. Mental Health Care Services are provided to the people and communities affected by the disaster and are a Staff Service function. Hard assistance and soft assistance change over time in every stage of the disaster relief operation. Therefore, "***System Capacity***" affects "***Emergency Relief System Performance***".

- Changes in the provision of resources over time depend on the kind and category of the event and the final impact on the community. Furthermore, they are decisive determinants for resource allocation and the perception of community concerning the treatment and satisfaction they received. Therefore, "***External Factors***", "***Affected Community Subsystem***" and "***Emergency Relief System Performance***" influence "***System Capacity***" (see Figure 2).

C. Emergency Relief System Performance: This subsystem describes performance parameters related to human and material resources as well as charitable contributions in form of donations, and evacuated client's perceptions.

- Resource allocation is what enables an organization to improve or maintain its performance. The correct operationalism of this construct is critical to the development of the system.

- Voluntary contributions, identified as Donations, constitute an important factor for the improvement of the system, concerning the acquirement of resources needed, in terms of supplies.

- Then "***Emergency Relief System Performance***" affects "***System Capacity***", since the availability of resources (equipment, personnel, etc) needed to support a disaster relief operation depends on the *effectiveness* and *efficiency* of how the system can respond when it is needed.

- Performance also depends on Service Quality provided to clients' aftermath since the correct distribution of resources, at the time and places they are needed in the immediate event can be the difference between satisfaction and dissatisfaction for the victims.

- The quality of service provided to the inhabitants hit by a disaster causes changes in the citizens' mind, since they evaluate the quality of the actions taken by the relief organizations by means of comparing it to perceived and received resources and treatment during the aftermath. Then "***System Capacity***" influences the "***Emergency Relief System Performance***".

- Outside the system there are "***External Factors***" that are always influencing "***Emergency Relief System Performance***" and vice versa (see Figure 2).

This research work focuses on the emergency relief system performance subsystem. This subsystem shows the overall architecture of the model and transmits information provided by the different agents represented.

1.9 RESEARCH CONTRIBUTIONS

The main contribution of this research is to provide decision makers with a dynamic framework to evaluate how different elements of the service delivery system interact with other factors to impact customer reactions to a disaster.

A second important contribution is to provide information for the correct allocation of emergency service's resources so that the victims' immediate needs are met in a more cost effective fashion and with the least delay possible.

A third contribution is the fact that this is the first time that as part of the systems perspective, operational data such as budget, number of volunteers and staff, number of shelters, etc., are correlated to victims' perceptions and satisfaction, vis-à-vis, different uncontrollable environmental factors such as demographic characteristics, wealth of the community, population density, etc.

2 LITERATURE REVIEW

"What is life? A madness. What is life? An illusion, a shadow, a story. And the greatest good is little enough; for all life is a dream, and dreams themselves are only dreams".

-- Pedro Calderón de la Barca --

This chapter begins by providing a framework for a classification of disaster relief organizations and then reviews the customer satisfaction, service quality and resource allocation literature, and relates it to literature in the disaster relief arena. It also reviews prior work published to date in disaster relief management as well as other approaches proposed to simulate disaster relief operations. It also reviews the system dynamics methodology and discusses studies that have used system dynamics in tandem with service quality, service quality management and evacuation operations. Finally, it reviews data mining approaches to find patterns and relationships in large data sets.

2.1 DISASTER RELIEF ORGANIZATIONS

When disaster strikes, Disaster Relief Organizations (DROs) examine the physical nature of the event and the major risk factors for human casualties. DROs also investigate victim and survivor perceptions of an outage risk, and individual or household responses to the hazard (Bluestein and Howard 1999, Legates and Biddle 1999).

The Department of Homeland Security was established by the President and Congress of the United States of America (Homeland Security Act of 2002) to coordinate federal programs and to assist state and local governments in responding to terrorist attacks and disasters. Chartered to provide guidance to federal, state, and local agencies regarding a national response to a potential or actual terrorist threat, the Department of Homeland Security created the National Response Plan (NRP) and the National Incident Management System (NIMS). Under the NRP and NIMS, the President will designate a Principal Federal Official to coordinate activities of all federal agencies during an incident of national significance.

The NRP assists in the important homeland security mission of preventing terrorist attacks within the United States; reducing the vulnerability to all natural and manmade hazards; in addition, minimizing the damage and assisting in the recovery from any type of incident that occurs (Department of Homeland Security, 2004). The interim Federal Response Plan (FRP) provides guidance for the coordination of federal assistance. Following natural disasters it provides the mechanism for coordinating delivery of federal assistance and resources to augment efforts of state and local governments, supports implementation of the individual agency statutory authorities, and supplements other federal emergency operation plans developed to address specific hazards (American Public Health Association).

The emergency management community uses the term "function" to describe each of 12 responsibilities within the FRP. These responsibilities are grouped into 12 Emergency Support Functions (ESFs), each headed by an agency with the support of the others. All of the ESFs directly or indirectly affect efforts to protect the health and welfare of disaster victims (see Tables 1 and 2).

Table 1. Emergency Support Functions. National Response Plan, 2004.

Emergency	Responsibility	Lead Agency
ESF 1: Transportation	• Federal and civil transportation support. • Transportation safety. • Restoration/recovery of transportation infrastructure. • Movement restrictions. • Damage and impact assessment.	**US Department of Transportation**
ESF 2: Communications	• Coordination with telecommunications industry. • Restoration/repair of telecommunications infrastructure. • Protection, restoration, and sustainment of national cyber and information technology resources.	**US National Communications System**
ESF 3: Public Works and Engineering	• Infrastructure protection and emergency repair. • Infrastructure restoration. • Engineering services, construction management. • Critical infrastructure liaison.	**US Department of Defense, US Army Corps of Engineers**
ESF 4: Firefighting	• Firefighting activities on Federal lands. • Resource support to rural and urban firefighting operations.	**US Department of Agriculture, Forest Service**
ESF 5: Emergency Management	• Coordination of incident management efforts. • Issuance of mission assignments. • Resource and human capital. • Incident action planning. • Financial management.	**Federal Emergency Management Agency**
ESF 6: Mass Care, Housing and Human Services	• Mass care • Disaster housing • Human services	**American Red Cross**
ESF 7: Resource Support	• **Resource support (facility space, office equipment and supplies, contracting services, etc.)**	**US General Services Administration**

Table 2. Emergency Support Functions. National Response Plan, 2004 (Continued).

Emergency	Responsibility	Lead Agency
ESF 8: Public Health and Medical Services	• Public health. • Medical. • Mental health services. • Mortuary services.	**US Department of Health and Human Services**
ESF 9: Urban Search and Rescue	• Life-saving assistance. • Urban search and rescue.	**Federal Emergency Management Agency**
ESF 10: Oil and Hazardous Materials Response	• Oil and hazardous materials (chemical, biological, radiological, etc.) response. • Environmental safety and short and long term cleanup.	**Environmental Protection Agency**
ESF 11: Agriculture And Natural Resources	• Nutrition assistance. • Animal and plant disease/pest response. • Food safety and security. • Natural and cultural resources and historic properties protection and restoration.	**Department of Agriculture**
ESF 12: Energy	• Energy infrastructure assessment, repair, and restoration. • Energy industry utilities coordination. • Energy forecast.	**US Department of Energy**
ESF 13: Public Safety and Security	• Facility and resource security. • Security planning and technical and resource assistance. • Public safety/security support. • Support to access, traffic, and crowd control.	**Department of Homeland Security, Department of Justice**
ESF 14: Long-Term Community Recovery and Mitigation	• Social and economic community impact assessment. • Long-term community recovery assistance to States, local governments, and the private sector. • Mitigation analysis and program implementation.	**Department of Housing and Urban Development, Department of the Treasury Small Business Administration**
ESF 15: Externals Affairs	• **Emergency public information and protective action guidance.** • **Media and community relations.** • **Congressional and international affairs.** • **Tribal and insular affairs.**	**Federal Emergency Management**

A depiction of these functions can be seen in the following diagram (see Figure 3).

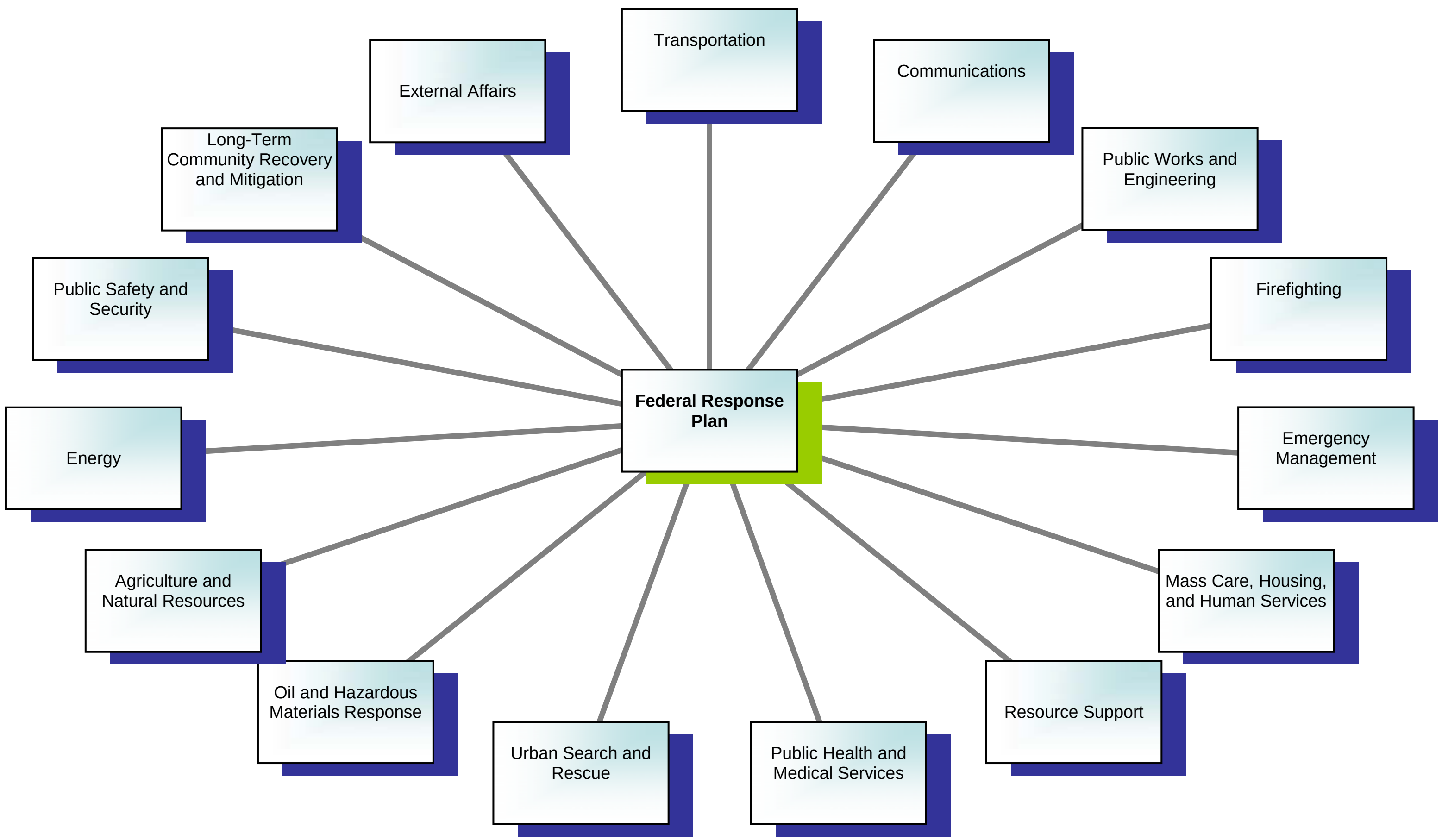


Figure 3. Emergency Support Functions. Author's Elaboration, 2007.

Based on the above framework, nonprofit organizations that provide social and humanitarian services to victims of disaster, (such as the Red Cross) can be classified as an aid organization limited in scope to function: ESF 6; mass care, but coordinating with agencies involved in all 12 functions. These aid, or social service agencies are but one element. The American Red Cross is one branch of a global movement dedicated to providing relief to victims and helping people prevent, prepare and respond to emergencies and/or disasters. In the United States and its territories, one of its major areas is disaster relief which direct services are:

- **Disaster Health Services (DHS):** Provide emergency and preventive health services to people affected by disaster and to Red Cross staff providing disaster relief. Cooperate in approved, appropriate research designed to mitigate disaster-related illness, injury, and death. Provides support to persons who have disaster-related or disaster-aggravated health needs. Assist disaster victims in finding resources to meet health-related financial obligations. Provide Red Cross financial assistance to clients for medical bills, as necessary.

- **Disaster Mental Health Services (DMHS):** Provide emergency and preventive mental health services to people affected by a disaster and to Red Cross workers assigned to a disaster relief operation and their families; services include education about stress and its effects, methods of coping; In addition, advocacy, crisis interventions, and referral services to resources to meet mental health related problems.

- **Disaster Welfare Inquiry (DWI):** Responds to inquiries about the health and well being of individuals and families within the affected area. Collects information about such persons. Provides services leading to reunification of family members in the affected area and provides information for disaster welfare inquiry bulletins issued by national headquarters to Red Cross units.

- **Family Services (FS):** Emergency Assistance provides individual assistance at service delivery sites and through outreach, by referral to government and/or voluntary agencies through distribution or financial assistance. Additional Assistance assists the clients to plan their recovery by using all appropriate personal, communities, and government resources. Building and Repair provide technical guidance about the repair and/or reconstruction of buildings and maintains liaison with contractors providing these services to the disaster relief operation.

- **Mass Care (MS):** Provides congregate shelter facilities, fixed and mobile feeding services for disaster victims and emergency workers in the affected area, and distribution of supplies and commodities to people affected by the disaster (American Red Cross of Central Alabama, 2006).

2.2 CUSTOMER SATISFACTION AND DISASTER RELIEF

Disaster relief organizations have to develop and maintain integrated operational capability to perform two functions:

- Respond to and recover from potential disasters and,
- Ensure that when disasters strike the immediate needs of disaster victims are met with necessary resources.

The above requires that the disaster recovering planning function investigates how the victims perceive and feel the way they were treated during an outage.

There are studies that measure the disaster victim's satisfaction, and provide information about the support received, and the source of assistance. This is the case of Quick Response Report #154. In this report, Paul and Leven (2002) concentrated on the satisfaction with emergency aid delivered to victims of the 2001 tornado in Hoisington. This research provided information to four major external aid sources (government agencies, private insurance companies, volunteer organizations, and business communities) and others involved in delivering disaster relief in the aftermath of a tornado. The study also evaluated overall satisfaction with the support that survey respondents received and their satisfaction with each source of assistance. It was assessed by a sample survey administered among tornado victims in Hoisington (Paul and Leven, 2002).

In 2006, Paul also provided an overview of advances and challenges in disaster relief, concentrating mainly in international disaster operations, and providing evidence that due to changes occurred in disaster relief area, relief efforts have become more integrated with development projects.

Researches as Susman et al., (1983) and Sollis (1994), added that the underdevelopment and the marginalization of victims of extreme natural events happen because disaster relief efforts in developing countries are not linked with development interventions. To reinforce this assertion, Paul (2006) explained that since 1990 a pragmatic combination of "disaster" and "development" activities and programs seemed to be the preferred option of many NGOs (Non-governmental organization). Many relief agencies had realized that "development" is about reducing vulnerability of people, and communities to both anthropogenic and natural hazards.

This is an important advance in this area. The integration of development and disaster relief by both NGOs and national governments was performed with the aim to reduce the vulnerability of the poor and marginalized groups to natural hazards by empowering the most deprived sections of society. This is done by alleviating poverty, raising democratic consciousness, encouraging the poorest to articulate their social and economic needs, and by combining short-term relief and long-term preparedness support (Matin and Taher, 2001). With this evidence, these authors determined that it is possible to minimize the physical and human consequences of future disasters, linking the disaster and development through mitigation and preparedness measures.

One study that concentrated in the perceptions of hurricane Katrina victims is the one written by Brodie et al. (2006). These authors highlighted the need for better plans for emergency communication and evacuation of low-income and disabled citizens in future disasters and shed light on choices facing policymakers in planning for the long-term health care needs of vulnerable populations. The methodology used was a survey designed by the Washington Post, the Kaiser Family Foundation, and the Harvard School of Public Health.

The study pointed to the importance of investigating the factors behind the failure of a slow response to Hurricane Katrina, and the need to prevent future failures. Authors presented results supporting the idea of developing better emergency communication plans for urban evacuation situations. Residents, particularly those of low-income areas, need more explicit information on how to find safety or evacuate if they have no car, financial resources, or a place to stay outside the city, or if someone else in their family is physically disabled.

According to this study, their evaluation of the results from Red Cross shelters showed that, in comparison with evacuees from higher income households, those from low-income households were less likely to own a car, to have enough money to pay for alternative transportation, or to have a place to stay once they left the city. The authors also suggested the necessity of providing short-term public insurance coverage for those without coverage or without access to the public hospitals on which they typically depend.

Therefore, these authors are the first to make a direct link between victim’s needs, satisfaction, infrastructure, and resource allocation. Brodie et al. (2006) stressed the need for a planning mechanism for future disasters that will allow DROs to have the right amount of resources.

2.3 RESOURCE ALLOCATION AND DISASTER RELIEF

As Paul (2006) pointed out, in the case of disaster relief agencies, successful or adequate resource allocation is linked to satisfying the needs of victims. In that sense, adequate planning has been regarded as the basis for resource allocation.

Prior to 2004, the most known framework for disaster relief was a planning tool known as the “Emergency Response Cycle” (Cutter, 2003). However, after the Tsunami of 2004, and the Gulf Hurricanes of 2005, the world became more aware of the need for better planning tools. Supply Chain Management and other frameworks began to be suggested as necessary for resource allocation in disaster relief operations (Wassenhove, 2006). The next section describes the emergency response cycle.

2.3.1 The Emergency Response Cycle

The emergency response cycle contains actions that occur immediately after an event such as rescue and relief, up until longer-term stages in the recovery process. As communities recover and rebuild in the aftermath of the disaster, the cycle moves into the mitigation phases where reconstruction is undertaken in ways that aim to reduce vulnerability and improve preparedness for the next unexpected event. Actions/elements of the cycle as described below (Cutter, 2003) (see Figure 4).

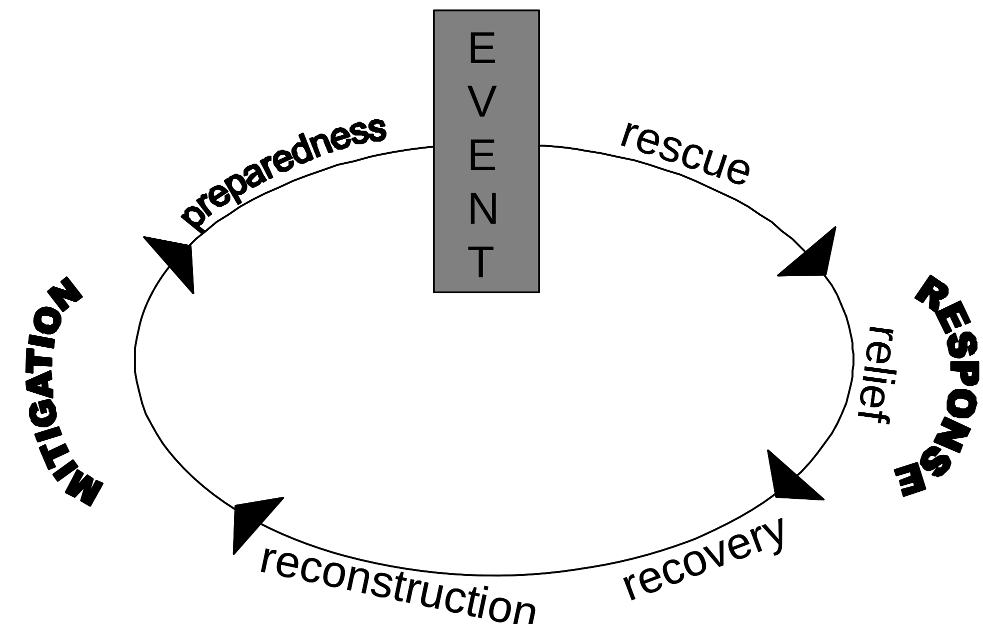


Figure 4. Schematic Representation of the Emergency Response Cycle. Cutter, 2003.

A. Mitigation: Includes the activities which eliminate or reduce the likelihood of an occurrence of an emergency, or the effects of actual emergencies.

B. Emergency Preparedness: Is the preliminary research and planning to determine significant vulnerabilities, organization's reactions in case an emergency occurs, management of resources available, and ways to obtain additional resources to respond effectively. These activities are designed to help save lives and minimize damage by preparing people to respond appropriately when an emergency is imminent or has occurred. Preparedness measures improve response operations by ensuring that a plan for response is present, personnel are trained to respond, and that the necessary resources with which to respond are available.

The Ontario Ministry of Agriculture, Food and Rural Affairs (1999) explained the four phases of emergency preparedness are cyclical in nature. Each phase lays the requirement and groundwork for the next one. The phases are:

- **Research**: "In this phase the emergency preparedness manager must review all important directives, charters and, by-laws to establish legal roles and functions; recognize the areas in which operations are vulnerable; In addition, determine the resources that are required for assigned emergency roles and contrast this to the resources that organization currently has or has access to and it is essential to make arrangements to fill the gaps".

- **Planning**: "Includes production of the plan. The minimum criteria for an emergency preparedness program must be: the activity must respect federal, provincial and municipal legislation, organization, mandates, and their emergency roles and responsibilities; should respect current plans to the maximum possible area; should involve the personnel and organizations expected to contribute to, or be affected by the emergency plan; should be supported on accepted emergency management principles; should address the full scope of the hazards to which the organization could be expected to respond".

- **Implementation**: Includes providing the resources necessary to execute the plan, as well as training for it.

    - ✓ **Resources**: "It is necessary to guarantee that the organization owns, or at the time of the emergency can gain access to, all of the necessary equipment, personnel and facilities. It is possible to obtain these resources in one of three ways: Equipment and personnel that are possessed by or work for your organization, borrowing the required resources from another organization, and/or renting the equipment for the emergency operation".

    - ✓ **Training**: "Once the Emergency Plan has been developed it is essential that all responders receive training on their roles and responsibilities assigned in the Plan".

- **Validation**: Once the plan and its supporting procedures and checklist have been defined, they are tested under simulated emergency circumstances to determine their validity. This is completed by exercising the plan and responders. The intent of the exercise is to test the plan, procedures and checklists and to practice the responders.

The Emergency Plan validation is a constant process. The Emergency Plan should be supported by a formal exercise program that tests all aspects of the Plan. It is not practical to implement all emergency functions and objectives during every exercise.

Therefore, the exercise program should be designed to guarantee that over a period of three to five years, all main emergency response functions and all organizational boundaries have been tested.

An exercise program lets the organization run progressively more challenging exercises over a period of time. This will ensure the repeated development of the emergency preparedness program and the prevalence of the responders. When it is necessary to make adjustments, or to improve plans, procedures or checklists it is necessary to come back to the research phase of emergency preparedness (see Figure 5).

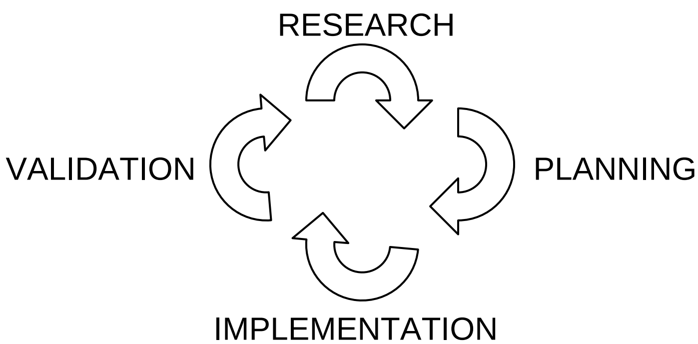


Figure 5. Schematic Representation of the Emergency Preparedness Cycle. National Voluntary Organizations Active in Disaster, 2004.

When the plan has been evaluated and deficiencies recognized, the emergency preparedness activities must go back to the research phase of the emergency preparedness cycle (Ontario Ministry of Agriculture, Food and Rural Affairs, 1999).

C. Response Operations: Happen during and immediately after an emergency. They protect life, decrease injury, and preserve the environment and property. They are also designed to give emergency assistance to victims, to diminish the change of secondary damage, and to speed the recovery operation (Ontario Ministry of Agriculture, Food and Rural Affairs, 1999). There are two phases to response:

- **Rescue:** Initial Responders in the emergency phase will be local fire and police departments, and search and rescue teams. Others who may initially respond include family, neighbors, and other community-based organizations. Rescue is distinguished by activities focusing on the protection of life and property. This is usually a very dangerous environment. The presence of untrained volunteers is not advisable. Response during this phase includes search and rescue, evacuation, emergency medical services, feeding and sheltering (National Voluntary Organizations Active in Disaster – Revised and Approved 2004).

- **Relief:** Basic human needs cared for are: Medical services and the provision of food, clothing and temporary shelter. Basic cleaning of homes, businesses and streets starts. Utilities start to be restored. Applications for assistance begin. People begin moving into temporary housing or went back home. Human, material and financial resources may begin to run into the community (National Voluntary Organizations Active in Disaster – Revised and Approved 2004).

D. Recovery: Continues until all systems have returned to normal, or next to normal. Short term recovery, returns support systems (e.g., food and water distribution and emergency health services) to minimum operating standards. Long-term recovery could maintain for years until the emergency area comes back to its prior state or is developed for purposes that are less emergency prone (Ontario Ministry of Agriculture, Food and Rural Affairs, 1999).

E. Reconstruction: Is referred to the rebuilding of damaged constructions and structures.

Emergency plans made in this field try to determine the amount and the type of resources needed to respond to an emergency, to preserve and minimize the impact in communities, but no one mentioned if they consider the victims feelings and perceptions.

The planning environment for the resource management function, are the factors that directly impact the ability of a country to satisfy resource demand, and resource-allocation decisions based on the disasters' victims perceptions, and manage support activities during response operations are all topics that must be considered in a disaster recovering planning.

The extent of this research work is enclosed in the disaster relief operation system. An illustration of this scope can be seen in Figure 6.

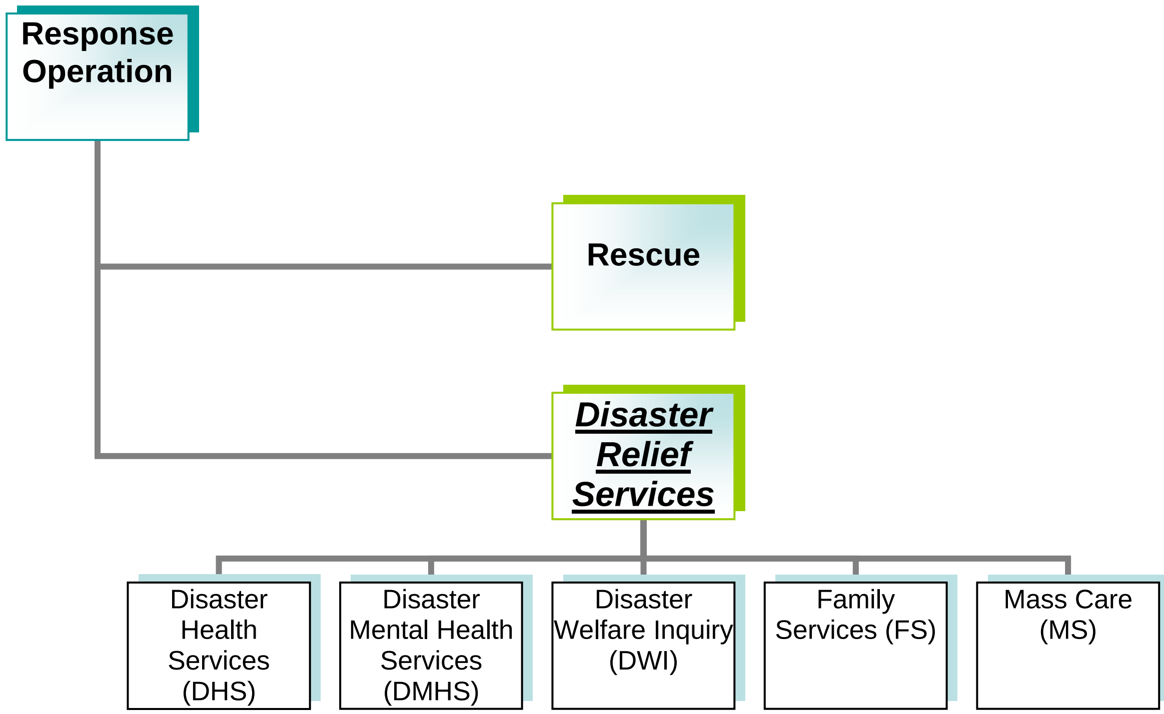


Figure 6. Disaster Relief Services. Author's Elaboration, 2007.

This research proposes a new model for disaster relief operations, where quality of service in emergency resource allocation is incorporated as an evaluation process of the emergency response cycle. Currently, the interactivity between the service provider's (disaster relief organizations) and the service receiver's (disaster's victims) expectations and perceptions are ignored. Therefore, the objective is to describe a system dynamics model which shows how resource-allocation and quality service factors influence human perceptions and reactions before, during and after an emergency.

2.4 SUPPLY CHAIN FOR HUMANITARIAN RELIEF

Logistics is defined as "the process of planning, implementing and controlling the efficient, cost-effective flow of and storage of goods and materials as well as related information, from point of origin to point of consumption for the purpose of meeting the end beneficiary's requirements" (Thomas and Mizushima, 2005). For humanitarians, logistics is the processes and systems involved in mobilizing people, resources, skills and knowledge, to assist vulnerable people affected by disaster (Wassenhove, 2006).

According to Wassenhove (2006), humanitarian organizations are beginning to understand the fact that logistics:

- Is crucial to the performance (effectiveness and speed) of existing and future operations and programs,

- Serves as a link between disaster preparedness and response, between procurement and allocation and between headquarters and the field,

- Provides a rich source of data, since it is this department that manages the tracking of goods, which could be used to analyze post-event effectiveness.

- It is the most expensive part of any disaster relief operation and the part that can mean the difference between a successful or failed operation.

That means, all logistics operations have to be designed in such a manner where they get the right goods to the right place and allocate to the right people at the right time.

A successful response occurs when a successful humanitarian operation mitigates the critical needs of a population with a sustainable decrease of their vulnerability in the shortest amount of time and with the least amount of resources (Tomasini and Wassenhove, 2004).

Humanitarian organizations are beginning to think more in terms of optimizing their performance by being better prepared. It is a fact that being better prepared guides them to a better response. The key to being better prepared, and perhaps the greatest dropping block in the humanitarian sector, is that logistics has to be recognized and understood as an intrinsic element of any disaster relief operation. This has to happen before the functions can be designed and preparedness enhanced throughout effective disaster management (Tomasini and Wassenhove, 2004).

Preparedness consists of five key elements that have to be in position to produce useful results. These in turn guide them to effective disaster management (see Figure 7).

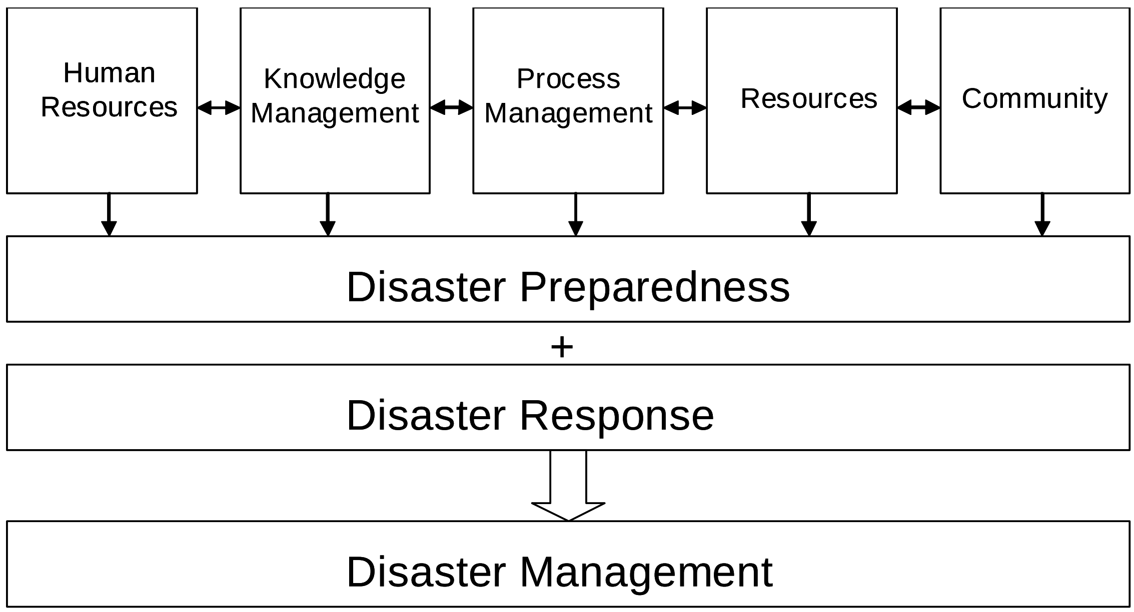


Figure 7. Creating Effective Disaster Management. Wassenhove, 2006.

Therefore, to be better prepared and hence have better response, all the key elements need to be linked. The systems and departments need to be set up so that they allow the flow of goods (material flow), information to guarantee cooperation and coordination (information flow) and funds from donor support and benefits or goods in kind (financial flows) between each element or 'link' in the chain.

This is important for the supply chain to work successfully in the private or humanitarian sectors. Though, the central issue that many humanitarian organizations face is finding the funds to finance the training and procedures that would lead to better preparedness and more effective logistical operations. Donations for a disaster are allocated for relief and not for training and investment on preparedness strategies in between disasters (Wassenhove, 2006).

Therefore, performance measurement is important to humanitarian organizations, especially when resources become tighter and they face new pressures for greater accountability for program impact and quality (Beamon, 2004).

The conceptual model of this research concentrates on the third level or echelon of Wassenhove's effectiveness model, disaster response, and within response, the specific functions of disaster relief.

2.5 SERVICE QUALITY

The quality of the service received by a victim of any catastrophic event is one of the key elements of this framework. To understand better what quality service means in this arena, a review of the service quality models proposed in the literature to date was made.

In the area of service quality, there are 19 models that have considered (different scenarios throughout the years. This section shows chronologically a brief review of six of them, made by Seth and Deshmukh in 2005, all of the constructs described in these models are related to the subject of this research work.

2.5.1 The Technical and Functional Quality Model (Grönroos, 1984)

According to Grönroos (1984), service Quality is defined as a perceived opinion resulting from an evaluation process where customers contrast their expectations with the service they perceive to have received. This author suggested that service quality matters can be split into two types: technical quality (what customer is actually receiving from the service) and functional quality (the manner in which the service is delivered) (see Figure 8).

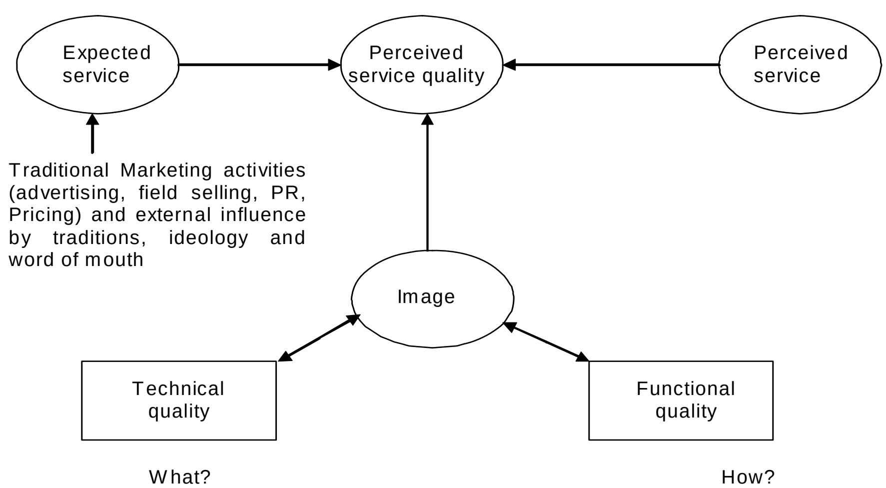


Figure 8. Service Quality Model. Seth and Deshmukh, 2005.

2.5.2 Gap Model (Parasuraman et al., 1985)

These authors proposed that service quality is a function of the differences between expectation and performance along the quality dimensions.

There are a plethora of measurement techniques for analyzing consumer satisfaction levels. Leadership in this area has been provided by Parasuraman et al. with the development of SERVQUAL procedure.

The SERVQUAL technique consists of 22 statements for assessing consumer perceptions and expectations concerning the quality of a service. Respondents are asked to rate their level of agreement or disagreement with the given statements on a seven-point Likert scale. Consumer's perceptions are based on the actual service they receive, while consumer's expectations are based on past experiences and information received. These statements characterize the dimensions of service quality (Douglas and Connor, 2003). These are:

A. **Reliability:** capability to perform the promised service consistently and precisely.

B. **Tangibles:** Appearance of physical facilities, equipment, personnel, and communication materials.

C. **Responsiveness:** Willingness to help customers and provide prompt service.

D. **Assurance:** The knowledge and courtesy of employees and their ability to express trust and confidence.

E. **Empathy:** The provision of gentle, individualized concentration to consumers.

Service quality for each dimension is summarized by a gap score (G), where G is the difference among consequent perception of delivered service (P) and expectation of service (E) for each item (G=P-E). The gaps are usually defined as:

- Gap 1: Customers' expectations versus management perceptions.
- Gap 2: Management perceptions versus service specifications.
- Gap 3: Service specifications versus service delivery.
- Gap 4: Service delivery versus external communication.
- Gap 5: The discrepancy between customer expectations and their perceptions of the service delivered.

There are two more major gaps in the service quality concept, which are shown in Figure 9, the new model is an extension of Parasuraman et al., 1985.

- Gap 6: The discrepancy between customer expectations and employees' perceptions.
- Gap 7: The discrepancy between employee's perceptions and management perceptions.

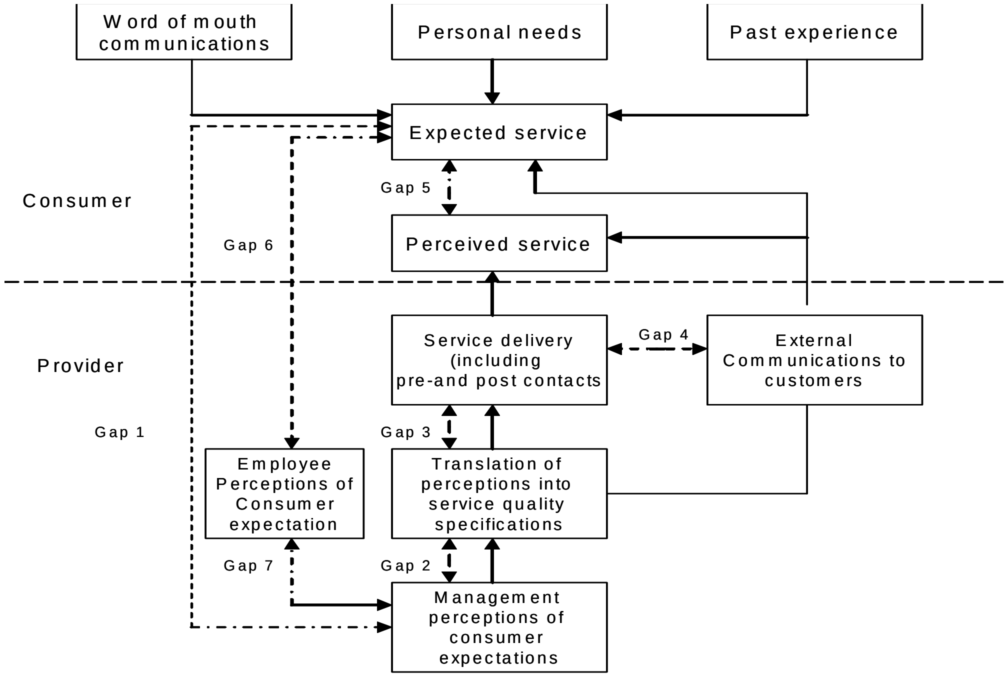


Figure 9. Model of Service Quality Gaps. Seth and Deshmukh, 2005.

According to Brown and Bond (1995), "the gap model is one of the best received and most heuristically valuable contributions to the services literature". The model recognizes seven key discrepancies or gaps linking to managerial perceptions of service quality, and tasks associated with service delivery to customers.

Clement and Selvam in 2006 collected from literature some potential quality inconsistencies and established relevant Service Quality Gaps (SQG) on their own and the resultant group of 14 SQGs is reorganized and renumbered in a coherent sequence.

Many others authors use the SERVQUAL concept and constructs but do not use GAP analysis to build up a service quality model. For example, Medina-Borja and Triantis (2002) studied the importance of including efficiency, effectiveness and customer satisfaction or a measure of service quality in performance measurement systems for social service organizations. Medina-Borja and Triantis also developed a scale for service quality performance that included timeliness, empathy, reliability, assurance and other constructs comparable to those on SERVQUAL. Those were combined with hard measures of service performance and one specific item for customer satisfaction.

Instead of using gap analysis these authors concluded for measuring service quality or customer satisfaction and optimum performance in social service agency it is necessary balancing three performance dimensions. These dimensions are: service quality, effectiveness, and efficiency. With service quality it is possible to obtain quality constructs from customer; effectiveness measures the client's change in perceptions, knowledge and behavioral intentions; and efficiency weight combinations of inputs (resources) and outputs (services).

Although, in the beginning easy adaptation to the requirements of a specific industry, as well as a resulting multi-dimensional and multi-perspective concept of service quality form the major advantages of the SERVQUAL approach, several shortcomings have been identified lately:

- The stability of the service dimensions across different branches of industry has been proven to be weak (Cronin and Taylor, 1992). In a study across four different industries, it was found necessary to add as many as 13 additional items to the service quality construct in various settings, while at the same time dropping as many as 14 terms from the original instrument based on results of factor analysis (Carman, 1990). This indicated that considerable customization was required to accommodate differences in service setting across industries (Hudson, Hudson and Miller G., 2004).

- The validity and reliability of the difference between expectations and performance has been seriously questioned (Carman, 1990). SERVQUAL critics have voiced their concerns for many years with respect to contextual, dimensional and empirical correctness considerations. While Parasuraman et al. in 1988 suggested the generic SERVQUAL instruments will cater for a broad range of services, Carman strongly suggested customization involving adding items, changing words, even adding or dropping relevant dimensions.

- SERVQUAL is also questioned in terms of the accuracy of measuring service quality as the discrepancy between expectations and perceptions. Teas 1993a like Cronin and Taylor 1992, considered the Perception-Expectation (P-E) specification to be of questionable validity and Teas even suggested the P-E measurement framework to be a potentially misleading indicator of service quality perceptions (Schembri and Sandberg, 2002).

- Application of the SERVQUAL approach is by definition limited to existing products, since experience and performance must both be taken into account. Hence the quality of service innovations can hardly be measured (Wetzels et al., 1995).

- Additive relationships between service dimensions are implied by the model, while this may not be a realistic assumption (Cronin and Taylor, 1992). Trade-offs between various service mix elements play an important role, particularly in an (international) marketing channel context (Wetzels et al., 1995).

- Cronin and Taylor in 1994 suggested that just performance, or SERVPERF, is the measure that best explains total quality. Yuksel and Rimmington in 1998 also suggested that performance only is the most reliable and valid measure of satisfaction. However, Parasuraman, Zeithaml, and Berry (1994) answered these criticisms by emphasizing that the critical indicator for a firm willing to improve its service quality is the amplitude and the direction of the gap between the expectation and perceptions scores not the perception itself. Tribe and Snaith in 1997 also suggested that performance alone cannot give a full picture of satisfaction.

- Other criticisms of SERVQUAL focus on the nature and number of dimensions. SERVQUAL replications, carried out in different service activities, show that the number of dimensions in the scale is not unique. For instance, Finn and Lamb in 1991 found out that the dimensions change when customers estimate product services (department stores) instead of pure services (banks).

- Cronin and Taylor in 1992 and 1994 considered SERVQUAL as undimensionable because they did not confirm the scale structure. Llosa, Chandon, and Orsingher in 1998 disagreed with the last criticism but did find that the 22 items of the SERVQUAL scale do not clearly evoke, in respondents' minds, the five service quality dimensions. In fact, using a revised SERVQUAL scale, Parasuraman, Zeithaml, and Berry of 1994 moved away from their original five dimensions to three: reliability, tangibles, and a single factor for responsiveness, assurance, and empathy. Brady and Cronin in 2001 found that the service quality construct conforms to the structure of a third order factor model that ties service quality to distinct and actionable dimensions: outcome, interaction, and environmental quality. In turn, each has three sub dimensions that define the basis of service quality dimensions.

- The SERVQUAL measure is also criticized for its unstable nature. Systems thinking suggested and demonstrated that:

  - ✓ The instability of the SERVQUAL measure may lie in the delays and feedback inherent in the service delivery system and not in the measure itself.

  - ✓ The issue with the SERVQUAL measure is its inherently unstable expectation construct because it reflects changing customer's needs in the dynamic service delivery system (Chong, Lee and Tan, 1999).

2.5.3 Attribute Service Quality Model (Haywood-Farmer, 1988)

This model affirmed that a service organization has "high quality" if it meets customer preferences and expectations constantly. According to this, the separation of attributes into various groups is the first step for the development of a service quality model. Services contain three basic attributes: physical facilities and processes; people's behavior; and professional judgment (see Figure 10).

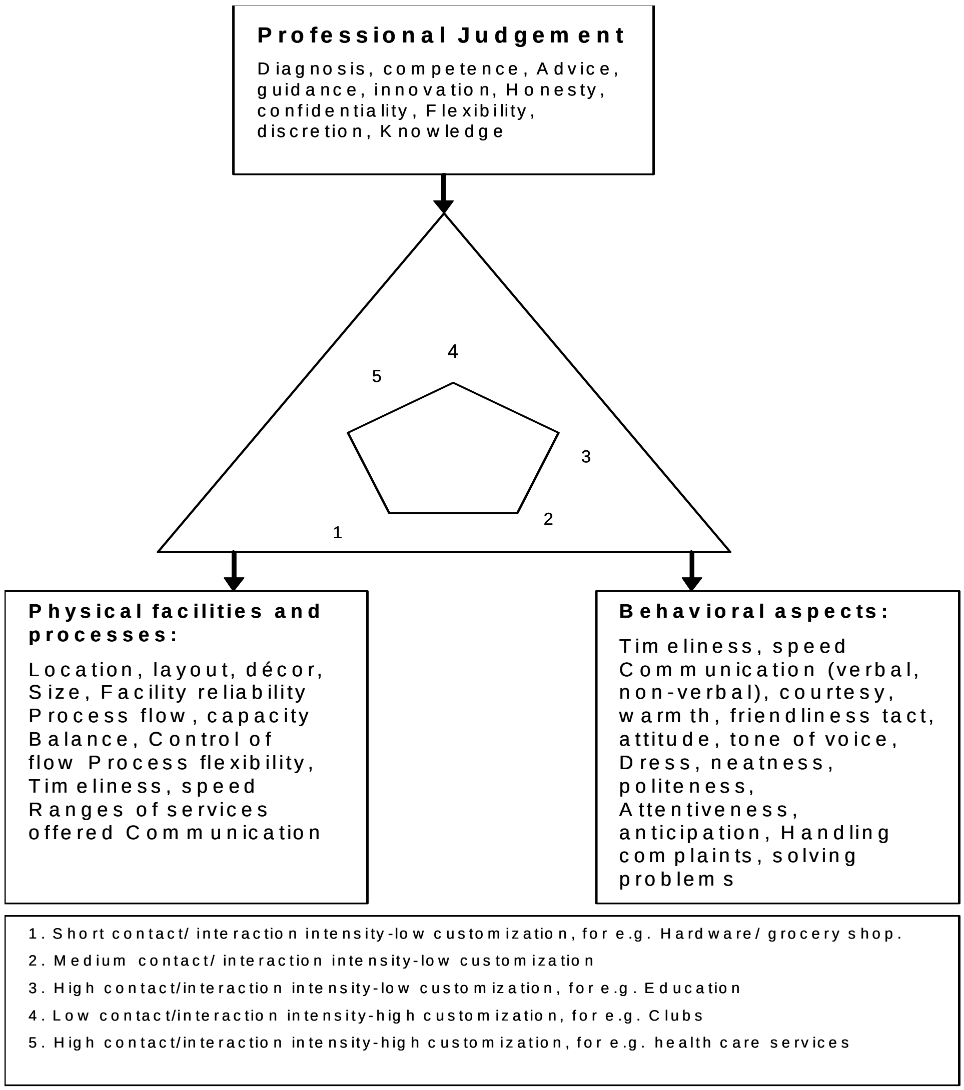


Figure 10. Attribute Service Quality Model. Seth and Deshmukh, 2005.

2.5.4 Synthesized Model of Service Quality (Brogowicz et al., 1990)

This model tried to integrate traditional managerial framework, service design and operations and marketing activities. The intention was to identify the dimensions linked with service quality in a traditional managerial framework of planning, implementation and control. The synthesized model of service quality described three factors, company image, external influences and traditional marketing activities as the factors influencing technical and functional quality expectations.

2.5.5 Model of Perceived Service Quality and Satisfaction (Spreng and Mackoy, 1996)

In this model the constructs perceived service quality and consumer satisfaction were developed to improve the understanding of these constructs. This model is an adaptation of Oliver's, 1993 model.

The model outlined the results of expectations, recognized performance desires, desired congruency and expectation disconfirmation on overall service quality and customer satisfaction (see Figure 11).

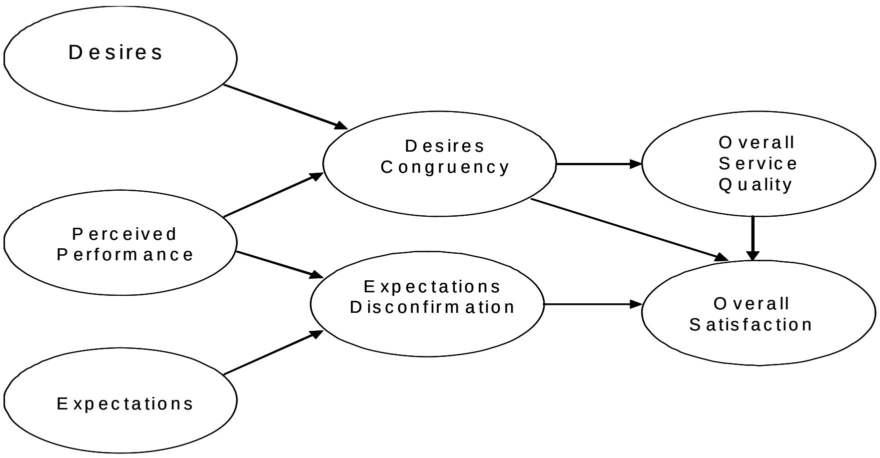


Figure 11. Satisfaction-Service Quality Model. Seth and Deshmukh, 2005.

2.5.6 Antecedents and Mediator Model (Dabholkar et al., 2000)

This model inspected some conceptual issues in service quality as the relevant factors related to service quality considered as components or experiences and the relationship of customer satisfaction with behavioral intentions (see Figure 12).

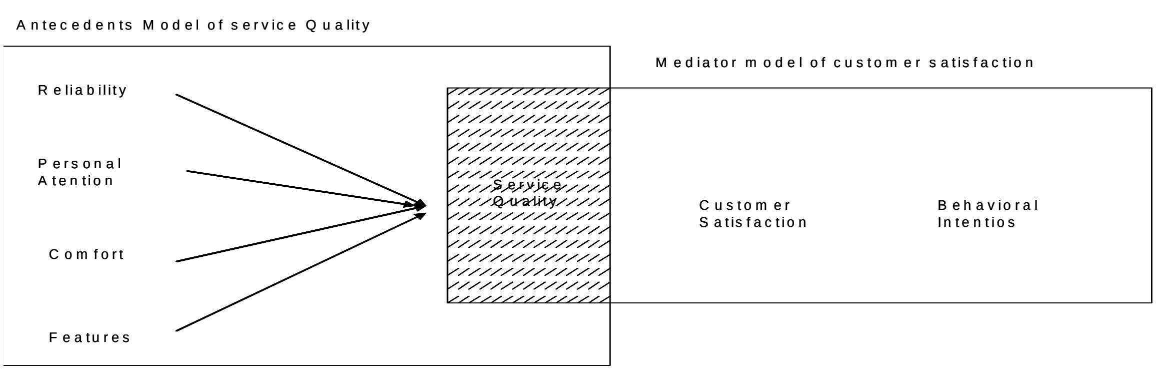


Figure 12. Antecedents and Mediator Model. Seth and Deshmukh, 2005.

2.6 SERVICE QUALITY IN EMERGENCY MANAGEMENT

As was cited by Medina-Borja in 2002, emergency services characteristics can turn the emergency victims' perception of how the service was delivered and the outcome of the service into a path-dependant error rate. Numerous authors (Furlong, Scott and Scheberle, 1998; Schneider, 1992) have documented that there is a gap between the way emergency victims perceive the availability, usability and effectiveness of the agency providing support and the way the agency itself identify their operations and ability to take action. This behavior pattern is caused by victims' expectations of the function of the agency and the help that they are permitted to receive. When this help is not immediately available, victims may consider that emergency management agencies has been unsuccessful delivering its service.

Research on customer satisfaction and customer's perceptions of effectiveness in these kinds of cases must consider this gap. Besides, it is a fact that not all individuals respond to traumatic events with the same pattern of adjustment (Freedy et al., 1992). That is because individual differences with regard to mediating variables (e.g. social support, coping behavior, etc.) may be very important in determining the reasons for unrealistic expectations of service. Post-emergency factors, such as current experiences, have also been noticed as influential of clients' perceptions of the emergency service (Medina-Borja, 2002).

This research is centered in developing a new model for evaluation of disaster relief operations, where quality service become an integer part in emergency resource allocation as a new phase of the emergency response cycle.

At present, there is no relationship between the service provider's (disaster relief organizations) and the service receiver's (disaster's victims) expectations and perceptions. Using and understanding diverse components of service quality models it is possible to create a link between disaster relief organizations and disaster's victims. These components of service quality are: service encounter, customer desires, and its effect on customer satisfaction perceptions of performance, customer decision process, perceptions of internal customers, internal suppliers that recognize the level of internal service quality perceived, the better use of resources to produce higher service quality levels, among others.

It is necessary that the whole theory, related to this topic, ties up all these concepts in order to describe a system dynamics model that reflects the distribution of resources and the factors of service quality which in turn influence the perceptions and human reactions of the clients, before, during and after an emergency.

2.7 SYSTEM DYNAMICS

System dynamics (Forrester, 1961) is a method for studying the world around us. Unlike other scientists, who study the world by breaking it up into smaller and smaller pieces, system dynamicists look at things as a whole. The essential idea of system dynamics is to understand how all the objects in a system interact with one another. The objects and people in a system interact through "feedback" loops, where a change in one variable affects other variables over time, which in turn influences the original variable, and so on (MIT, 2000).

However, how can one come to understand the whole system? For many experts, the solution is System Thinking - an approach for studying and managing complex feedback systems. For this reason the challenge is to move past slogans about accelerating learning and systems thinking into useful tools that help us understand complexity, design better operating policies, and lead effective change. System dynamics is a method to improve learning in complex systems.

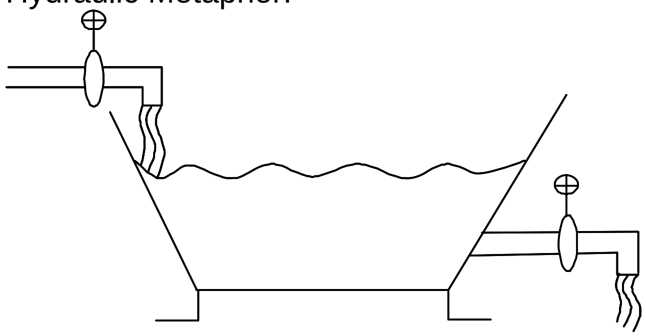
Successful intervention in complex dynamics systems needs more than technical tools and mathematical models. System dynamics is essentially interdisciplinary. System dynamics is discussed in the theory of nonlinear dynamics and feedback control built on mathematics, physics, and engineering (Sterman, 2001).

What system dynamics tries to do is comprehend the basic structure of a system, and understand the behavior that it can produce. Many of these systems and problems which are investigated can be built as models on a computer. System dynamics takes lead of the fact that a computer model can be of much greater complexity and carry out more simultaneous calculations than can the mental model of the human mind (MIT, 2000).

In 1961 Forrester created the stock and flow diagramming conventions based on a hydraulic metaphor - the flow of water into and out of pools. The stocks are seen as bathtubs of water. The amount of water in the bathtub at any time is the accumulation of the water running in through the tap less the water pouring out through the drain (assume no splashing or evaporation). The amount of material in any stock is precisely the accumulation of the flows of material in less the flows of material out,

Flows will be functions of the stock and other state variables and parameters. There are four comparable illustrations of stocks and flows structure (Sterman, 2000) (see Figure 13).

Hydraulic Metaphor:



Stock and flow diagram:

Integral Equation:

$$Stock(t) = \int_{t_0}^{t} [Inflow(s) - Outflow(s)] ds + Stock(t_0)$$ Eq. 2-1

Differential Equation:

$$\frac{d}{dt}(Stock) = Net\ Change\ in\ Stock = Inflow(t) - Outflow(t)$$ Eq. 2-2

Figure 13. Equivalent representation of stock and flow structure. Sterman, 2000.

2.7.1 Characteristics of Complex Dynamics Systems

In 2001, John Sterman described dynamic complexity as the often counterintuitive behavior of complex systems that occurs from the interactions of the agents over time. Dynamic complexity can begin even in a simple system with low combinatorial complexity. Moreover, he explains some of the characteristics of complex dynamics:

- **Constantly Changing:** Changes in the system happens at many scales, and these diverse scales sometimes interact.

- **Tightly Coupled:** The actors in the system interact with one another and with the ordinary world. Everything is attached to everything else.

- **Governed by Feedback:** Because of the stretched union among actors', the actions people feed back to themselves. People's decisions change the state of the world, causing alterations in nature and triggering others to operate, giving rise to a new situation which then influences the next decisions of people. Dynamics begin from these feedbacks.

- **Nonlinear:** Effect is not often proportional to cause, and what happens locally in a system does not apply in distant regions frequently. Nonlinearity often occurs from the basic physics of systems, also happens as multiple factors interact in decision making.

- **History-Dependent:** Taking one road regularly prevents taking others and decides where you end up.

- **Self-Organizing:** The dynamics of systems start from their internal structure. Often, small, random perturbations are increased and constructed by the feedback structure, producing patterns in space and time and creating path dependence.

- **Adaptive:** The capabilities and decision rules of the agents in complex systems change over time.

- **Characterized by Trade-Offs:** Time delays in feedback channels mean the long run response of a system to an intervention is frequently different from its short-run response.

- **Counterintuitive:** In complex systems cause and effect are far-away in time and space and there is an inclination to look for causes near the events that are trying to find an explanation. The attention of people is drawn to the symptoms of difficulty rather than the original cause.

- **Policy Resistant:** The complexity of the systems in which people are embedded overwhelms the skill to understand them.

2.7.2 Most Problematic elements of Dynamic Complexity

Sterman (2001) explained that the elements that people find most problematic are:

- **Feedback:** There is a feedback when the effects of people actions describe the situation people face in the future. The new situation alters persons' evaluation of the problem and the decision individuals take tomorrow.

- **Time delays:** Time delays among taking a decision and its effects on the state of the system are common and particularly difficult. Delays in feedback loops create instability and increase the tendency of the systems to oscillate.

- **Stock and Flows:** The accumulation and dispersion of resources are central to the dynamics of complex systems. Research illustrates that people's sensitive understanding of stock and flows is reduced.

2.7.3 Fundamental Modes of Dynamic Behavior

The fundamentals modes of behavior identified by Sterman (2000) are exponential growth, goal seeking, and oscillation. A simple feedback structure is generated for each one of them:

- Growth: occurs from positive feedback,

- Goal seeking happens from negative feedback and

- Oscillation starts from negative feedback with time delays in the loop.

Other general modes of behavior are S-shaped growth, S-shaped growth with overshoot and oscillation, and overshoot and collapse. They begin from nonlinear interactions of the fundamental feedback structures (Sterman, 2000) (see Figure 14).

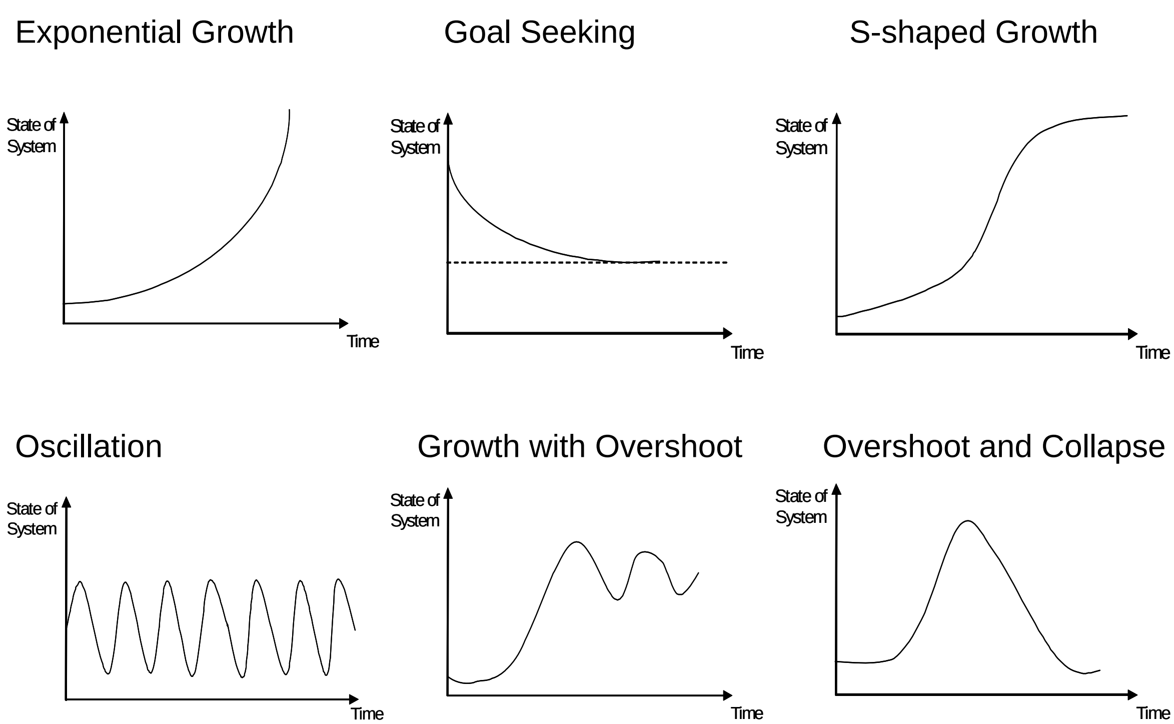


Figure 14. Common modes of behavior in dynamic systems. Sterman, 2000.

2.7.4 Casual Loop Diagram

System dynamics models have two features in common:

- They involve quantities that change over time, and
- They have control or feedback loops.

These mean that any actions taken in one time period influence the actions taken in subsequent periods (Richardson and Pugh, 1981).

Feedback is one of the main concepts of system dynamics. Drawing tools are used to describe the structure of the systems; this embraces casual loop diagrams and stock and flow maps.

A casual diagram contains variables attached by arrows indicating the casual influences between the variables. Variables are connected by Casual Links, illustrated by arrows, where cause and effect relationship is represented.

To each casual link a link polarity, either positive (+) or negative (-) is designated to specify how the dependent variable changes when the independent variable changes. Link polarities illustrate the structure of the system. They do not explain the behavior of the variables. They explain what would happen IF there were a change. They do not illustrate what actually happens.

The important loops are underlined by a loop identifier which explains if the loop is a positive (reinforcing) or negative (balancing) feedback. The loop identifier moves in the same direction as the loop to which it relates (Sterman, 2000) (see Figure 15).

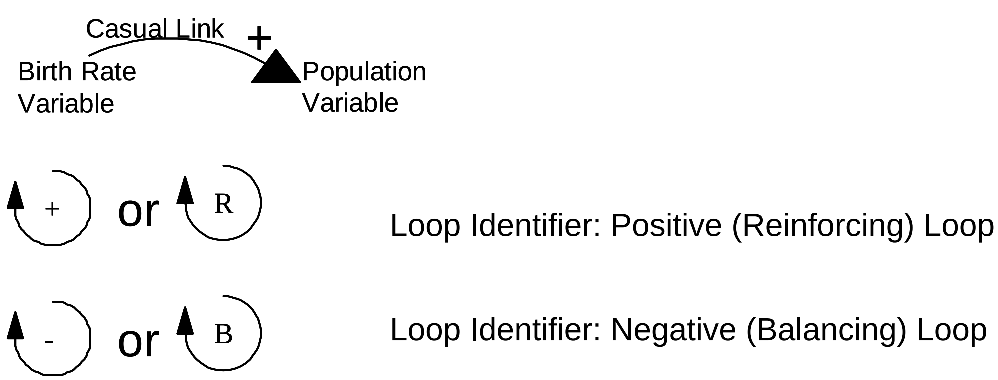
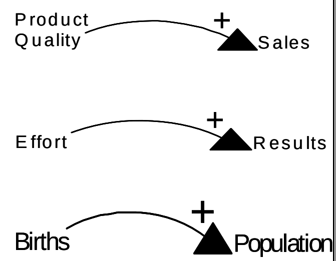
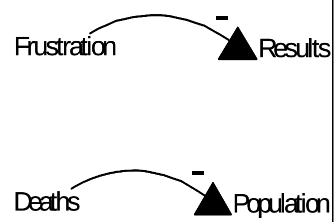


Figure 15. Casual loop diagram notation. Sterman, 2000.

A positive link indicates that if the cause augments, the effect augments above what it would otherwise have been, and if the cause reduces, the effect reduces below what it would otherwise have been. A negative link denotes that if the cause increases, the effect decreases below what it would otherwise have been, and if the cause decreases, the effect increases above what it would have been (Sterman, 2000).

In 2000, Sterman presented a table with the definitions of link polarity (see Table 3).

Table 3. Link polarity: definitions and examples. Sterman, 2000.

Symbol	Interpretation	Mathematics	Examples
	All else equal, if X increases (decreases), then Y increases (decreases) above (below) what it would have been. In the case of accumulations X adds to Y.	$\frac{\partial Y}{\partial X} > 0$ In the cases of accumulations, $Y = \int_{t_0}^{t} (X + ...)ds + Y_{t_0}$	
	**All else equal, if X increases (decreases), then Y decreases (increases) below (above) what it would have been.** **In the case of accumulations X subtracts from Y.**	$\frac{\partial Y}{\partial X} < 0$ **In the cases of accumulations,** $Y = \int_{t_0}^{t} (-X + ...)ds +$	

Quantities that modify over time are called variables (Roberts, 1978). Variables can be one of three types – level, rate or auxiliary. The state of the system is explained by the level variables with accumulations. The rate variables modify the accumulations of the level variables and control the flow. System policies control the rate variables, (Drew, 1994). The assumption employed to build the system dynamics model is that the structure can be symbolized using a series of level and rate variables (Forrester, 1961).

The level and rate variables are interlinked with a series of cause and effect relationships that decide the fundamental flows inside a system. These relationships and the flow bring the various elements together to be observed as a single holistic entity as opposed to having a group of individual components (Roberts, 1978).

Levels (also known as stocks, state variables, integrals) are accumulations of inflows and outflows over a period of time. Variables will have values at any given point in time. When the system is paused for an instant, level variables will have an assessment that decides the state at that instant (Pasupathy, 2006).

The distinction between stocks and flows is recognized in many disciplines. In 2000, Sterman provided a table with some common terms used to differentiate between stocks (levels) and flows (rates) (see Table 4).

Table 4. Terminology used to distinguish between stocks and flows in different disciplines. Sterman, 2000.

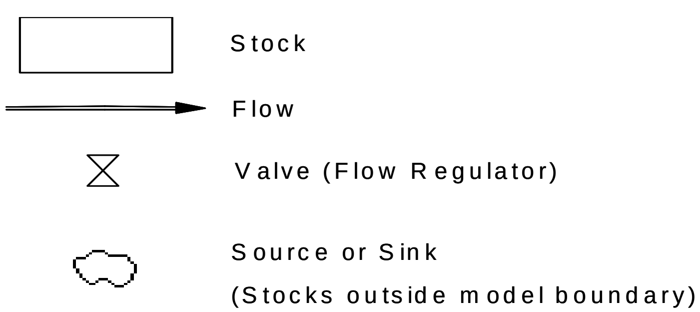
Field	Stocks	Flows
Mathematics, physics and engineering	Integrals, states, state variables, stocks	**Derivatives, rates of change, flows**
Chemistry	Reactants and reaction products	**Reaction rates**
Manufacturing	Buffers, inventories	**Throughput**
Economics	Levels	**Rates**
Accounting	Stocks, balance sheet items	**Flows, cash flow, income statement items**
Biology, physiology	Compartments	**Diffusion rates, flows**
Medicine, epidemiology	**Prevalence, reservoirs**	**Incidence, infection, morbidity and mortality rates**

2.7.5 Diagramming Notation and Mathematical Representation for Stocks and Flows

All stock and flows follows next diagramming notation (see Figure 16).

General structure:

The elements that compose it are:



And its functioning is represented as follows:

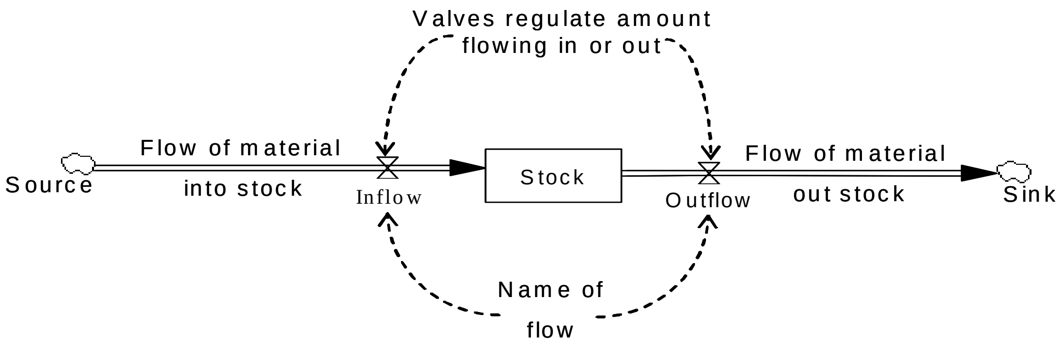


Figure 16. Stock and flow diagramming notation. Sterman, 2000.

2.7.6 System Dynamics and Customer Satisfaction

Customer satisfaction and its antecedent's service quality have been investigated widely in the system dynamics literature. The consequences of customer satisfaction have obtained less attention.

Bearden and Teel in 1983 proposed a study to better understand customer satisfaction by integrating complaint behavior into an explanation of customer satisfaction. The framework inspected reproduced a revision of Oliver's 1983 original model, to contain complaint behavior. Satisfaction is represented as a function of customer expectations operationalized as product attribute beliefs (Olson and Dover 1979) and disconfirmation. Expectations and disconfirmation were represented as unrelated, additive, and exogenous to the system. Being coherent with the multi-attribute explanation of attitudes, expectations and/or beliefs about product attributes were contained as determinants of attitudes which precede intentions. Satisfaction or dissatisfaction was assumed to control subsequent attitudes, intentions, and complaint behavior (see Figure 17).

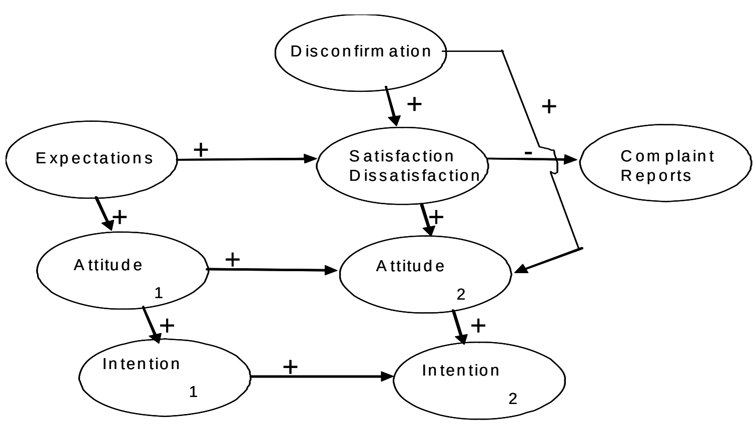


Figure 17. Theorical Antecedents and Consequences of Consumer Satisfaction. Bearden and Teel, 1983.

The theorized relationships among satisfaction and expectations and disconfirmation are based on Oliver's 1980a interpretation of Helson's 1964 adaptation level theory which hypothesized that one recognizes incentive in relation to an adjusted standard. Expectations were supposed to execute the function of an adaptation level in that they described the standard in opposition to which following performance was estimated. Disconfirmation was presumed to serve as a major force that causes movement away from the standard (Oliver 1981).

Though a substantial body of research supports the conjectured causal chain among beliefs, attitudes, and intentions, the effects of disconfirmation in conjunction with expectations on satisfaction have received less interest. Support for the additive and not linked assumption about expectations and disconfirmation was offered by the zero order correlations reported by Oliver (1980b). Disconfirmation may influence satisfaction and post purchase attitudes through an interactive relationship with expectations too. To help make this issue clear, another adaptation of the model was tested that included disconfirmation (Sharma, Durand, and Gur-Arie, 1981).

All of the relationship with the exception of the lane among satisfaction and complaining are theorized to be positive. For this negative path, satisfaction was presumed with an inverse relation to complaint behavior (Bearden and Teel, 1983).

Few empirical studies have researched the sequential linking of customer satisfaction, customer retention and profitability, and much of the literature is plagued by inconsistencies in definitions and unsubstantiated assumptions (Fornell 1992; Reichheld and Sasser 1990; Rust et al. 1993; Storbacka, Strandvik and Grönrooss 1994; Bolton and Drew 1991).

King, in 2000, applied concepts of system thinking to develop a conceptual model of the customer's satisfaction – profitability linkage. The use of causal loop diagramming allowed the investigation of feedback loops and facilitates the expansion of a deeper understanding of interdependencies between various constructs.

2.8 SYSTEM DYNAMICS AND RESOURCE ALLOCATION

A study of the Government-nonprofit service delivery relationship observed as a system dynamic approach, showed the development of a dynamic resource theory to clarify the process of government-nonprofit interdependence for human service delivery. The theory was considered from the application of system dynamics to dependencies occurring during the process of resource exchange (Cho and Gillespie, 2006).

The authors made it clear that resource dependence theory distinguishes feedback loops in the government and nonprofit relationship, but fails to explain the variables and relationships making up these feedback loops, and is not capable to explain the dynamic behavior of this relationship. This is considered as a major flaw since these feedback loops are the key determinants of behavior in social and economic systems (Forrester, 1968). A direct central point on the dynamics of resource exchange is the base for a successful theory (Cho and Gillespie, 2006).

To solve the problem above the authors created a Dynamic Resource theory where they explain how system dynamics decided the subject of the criticisms of traditional resource dependence theory:

- Resource dependence theory ignores the objectives that actors follow in the interaction process (Hall, 1991). Dynamic resource theory contains the goals required by each party in the exchange process. With objectives is possible to understand the government-nonprofit relationship since organizations always have a purpose for attained resources. Without consideration of objectives, the relationship attempts to be very abstract or unclear as reproduced in Saidel's (1991).

- The research on resource dependence theory ignores organizational groups (Galaskiewicz, 1985). Dynamic resource theory contains sets of actors in explaining the exchange process.

- Resource dependence researchers have not completely considered the effects of institutional environments on the decision-making process (Galaskiewicz, 1985). Dynamic resource theory can take into account the effects of environmental constraints on decision making. Institutional variations (e.g., changes in law) and political environments (e.g., shifts in societal priorities) do influence the options available to decision makers. Dynamic resource theory includes variables that incorporate these environments into the model.

- Resource dependence theory does not pact with the dynamics of the feedback loops driving government–nonprofit relations, which are necessary for understanding the continuously evolving relationship. Dynamic resource theory looks for the understanding of the dominant feedback loops driving government–nonprofit relations for human service delivery. Dynamic perspective shows the interrelations of positive and negative feedback loops that generate various categories of behavior patterns over time (Gillespie, 2000).

These authors' flexible dynamic resource theory in specifying goals, alliances, environmental constraints, and feedback loops releases new possibilities for a deeper understanding of the government–nonprofit relationship (Cho and Gillespie, 2006).

Although the dynamic resource theory offers a powerful approach to understand complex dynamic process where multiple factors evolve over time; it is the purpose of the SQRC model to perform it. Since ERC relationships evolve over time, mechanisms governing the emergency service's resource-victims satisfaction relationship are essentially static. Ongoing studies do not take into account how the relationship is changing over time. There have been no attempts to study this relationship dynamically.

This research proposes a development of a dynamic Service Quality Response Cycle (SQRC) Model to map the process of interdependence between resource allocation and human service satisfaction and hypothesize key mechanisms governing this relationship.

2.9 SYSTEM DYNAMICS AND EVACUATION

Ahmad and Simonovic in 2001 developed a computerized simulation model to describe human behavior during flood emergency evacuation, using a system dynamics approach. The model simulated the approval of evacuation orders by the residents of the area under risk; number of families in the process of evacuation; in addition, time needed for all evacuees to reach protection. The model is conceptualized around the flooding conditions (physical and management) and the main set of social and mental factors that determined human behavior before and during the flood evacuation.

This study focused on the subjects related to the emergency management, provision of assistance and conduct of the evacuation process. Human behavior during evacuation, in response to a disaster warning, was captured within a system dynamics model that allows emergency managers to develop the best possible response strategy in order to reduce the negative impacts of flood disaster. Model relationships and all other necessary data were achieved through interviews conducted in the Red River Basin after the flood of 1997.

The system dynamics model was capable of simulating the effect of different flood evacuation policies. The major benefit was that by understanding how a specific structure of feedback loops is capable of generating the observed behavior, it was possible to get insights into potential results. In this way the model guided emergency managers through most optimistic, most pessimistic, and in-between scenarios. The flood evacuation model is accessible for use by emergency managers, and it is expected that it can lead to a higher quality of decisions and a higher level of emergency preparedness. According to Simonovic and Ahmad (2005), the ability to capture specific features of the evacuation process during the flood emergency and to answer questions makes this model a powerful planning and analysis tool aimed at preventing the loss of life and the minimization of material damage (Simonovic and Ahmad, 2005).

Among the principal variables embraced by this model were the number of families under the flood threat, population in the process of evacuation, inundation of refuge routes, flood conditions (precipitation, river elevation, etc.), and different flood warnings and evacuation orders related variables (see Figure 18).

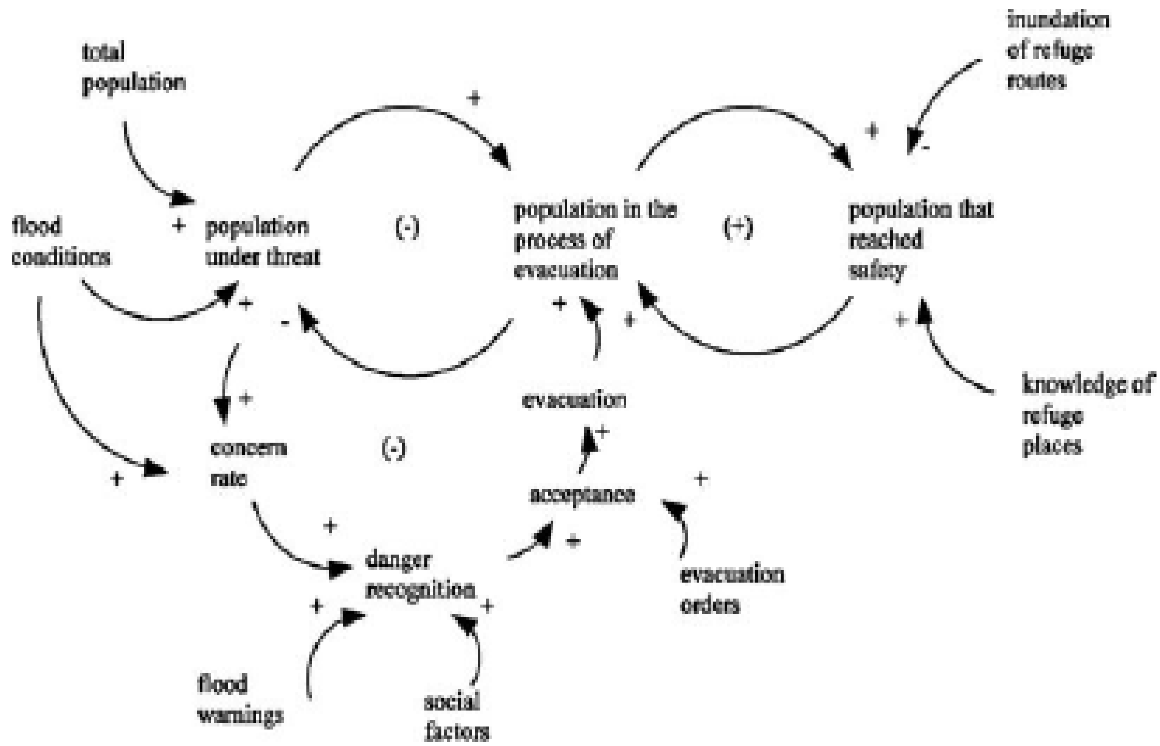


Figure 18. Causal Diagram of a Behavioral Model for Evacuation Planning. Simonovic and Ahmad, 2005.

Unlike the previous model, the main purpose of the Service Quality Response Cycle (SQRC) is to allow for the different policy options available to hurricane emergency managers to be evaluated before an emergency situation occurs. In this research, data were collected for the Katrina hurricane disaster. To demonstrate the utility of the model, Rita Hurricane data were used. Besides, the SQRC includes the availability of aid resources deployed by the American Red Cross.

2.10 DATA MINING AND THE IDENTIFICATION OF CUSTOMER CHARACTERISTICS AND BEHAVIORS

Keiningham et al. (2006), employ CHAID analyses to test hypotheses to establish relationships between employee satisfaction, customer satisfaction, and business performance. The authors set up that these relationships can be thought of as the result of three key linkages:

- Employee satisfaction to customer satisfaction: Heskett et al. (1997) proposes that the satisfaction of employees reflects on customers, and vice-versa, resulting in a cycle of good service. In this study, Keiningham et al. (2006) demonstrated that employee satisfaction will be positively or asymmetrically linked to changes in customer satisfaction.

- Employee satisfaction to financial performance: Pritchard and Silvestro (2005) observe that possible asymmetries and non-linearity of certain performance relationships may have impacted the results of their model. In this study, Keiningham et al. (2006) authors revealed that employee satisfaction will be positively or asymmetrically linked to changes in sales.

- Customer satisfaction and financial performance: Schneider et al. (2003) set up that there is ambiguity in the literature over levels of analysis in general and the employ of aggregated individual level data in particular. Given that asymmetry has been discovered in among customer satisfaction and customer behavior, and that customer behavior makes a straight impact on firm financial performance, some studies have conclude that the relationship between customer satisfaction and financial performance will be asymmetric at the aggregate firm level. It is in this way that this study, Keiningham et al. (2006) demonstrated that customer satisfaction will be positively or asymmetrically linked to changes in sales.

With the use of Pearson's correlations authors could establish the correlation between two variables which reflected the degree to which the variables are related. As a final check authors employed Chi-Square Automatic Interaction Detection (CHAID) to examine each of the customer attributes and changes in sales.

As a result of this procedure the authors found that:

- The relationship between employee satisfaction and customer and/or business outcomes are not straightforward.

- Customers' overall level of satisfaction was not joined to changes in sales.

- For researchers, authors' findings identify a need for more complex models considering the relationship of employee satisfaction to customer satisfaction to business outcomes. It also was demonstrated the need for longitudinal data when conducting such analyses. Due to the apparent asymmetry in the data, it appeared necessary to use proportions in addition to mean satisfaction levels.

- For managers, authors' findings appear to indicate that the typical dependence on simple mean satisfaction scores is unlikely to adequately explain changes in sales. Managers must preserve satisfaction levels on those attributes where consistent performance is linked to sales (Keiningham et al., 2006).

2.11 EVACUATION

Is the movement of people from a dangerous site due to the threat or occurrence of a disastrous event that takes place during hurricane emergencies. Hurricane situations can require a regional ability to move large numbers of people in a safe and timely manner.

The Hurricane Katrina experience demonstrates that a lack of prior planning combined with poor operational coordination, which produced a weak Federal performance in supporting the evacuation of those most vulnerable in New Orleans and throughout the Gulf Coast, following Katrina's landfall. The Federal effort lacked decisive elements of prior planning, such as evacuation routes, communications, transportation assets, evacuee processing, and coordination with State, local, and non-governmental officials receiving and sheltering the evacuees, because of poor situational responsiveness and communications throughout the evacuation operation. FEMA had difficulty providing buses through ESF-1, Transportation, (with the Department of Transportation as the coordinating agency). FEMA also had difficulty delivering food, water, and other critical commodities to people waiting to be evacuated, most significantly at the Superdome (The White House).

Therefore, emergency evacuation encompasses an extensive diversity of subjects and detailed situations. Within the body of the literature there are discussions ranging from transportation decisions and risk models to victims behaviors in disasters.

2.11.1 Transportation

It is critical to understand why so many people disregard evacuation orders. Before and after Katrina struck some people refused to evacuate because they faced situations like: logistical or financial barriers obtaining transportation; some had nowhere to go and were afraid of emergency shelter conditions, and some stayed to protect their property or pets.

Then, disaster can present several transportation issues such as:

- Evacuations before, during or after an event, and adequate accommodation of evacuees at refuge destinations.
- Delivery of emergency supplies and services, including water, food, medical care, utility maintenance, law enforcement, etc.
- Search and rescue operations.
- Quarantine.
- Transportation infrastructure repair.

Then, specific transport issues vary depending on the type and scale of the disaster. Hurricanes require all the aspects mentioned above. Therefore, emergency transportation and public transit services are an important component of all emergency preparedness efforts (Litman T, 2006).

During Katrina disaster, automobile evacuation functioned satisfactorily. The plan, which involved using all lanes on major highways to provide accommodation outbound vehicle traffic, was well engineered and publicized (Wolshon, 2002). Motorists were able to flee the city, although congestion resulted in very slow traffic speeds and problems when vehicles ran out of fuel or had other mechanical problems (Litman T, 2006).

However, there was no effective plan to evacuate transit dependent residents. This indicated that public officials were responsive and willing to accept significant risk to hundreds of thousands of residents unable to evacuate because they lacked transportation. The little effort that was made to assist non-drivers was careless and incompetent. Public officials provided little guidance or assistance to people who lacked automobiles (Renne, 2005). The city established ten pickup locations where city buses were to take people to emergency shelters, but the service was unreliable. Transit dependent people were directed to the Superdome, although it had insufficient water, food, medical care and security, it led to a medical and humanitarian crisis (Litman T, 2006).

2.11.2 Factors Influence Decision for Evacuation

Social science researchers have developed a deeply understanding of the factors influencing evacuation fulfillment. The focus of the research has been on whether or not people evacuate when advised to do so (see Lachman et al., 1961; Withey, 1962; Williams, 1964; Anderson, 1969, Drabek, 1969, 1983; Drabek and Boggs, 1983; Drabek and Stephenson, 1971; Baker, 1979; Quarantelli, 1980, 1984; Perry, et al. 1981, 1982; Perry, 1979; Leik et al., 1981; Cutter and Barnes, 1982; Perry and Greene, 1982, 1983; Stallings 1984; Perry and Mushkatel, 1984; 1986; Mileti and Sorensen 1988, Dow and Cutter, 1998, Lindell and Perry, 2004).

Mileti and Sorensen (1988) characterize the process as sequential process:

- Hearing the warning.
- Understanding the contents of the warning message.
- Believing the warning is credible and accurate.
- Personalizing the warning to oneself.
- Confirming that the warning is true and others pay attention to it.
- Responding by taking a protective action.

Social scientists have identified both general and specific factors that affect the warning response process which include sender and receiver factors, situational factors, and social contact. The chief way warning response can be affected by the emergency planner is in the design of the warning system including the channel of communication, public education and specific wording of the emergency message (Sorensen and Vogt, 2006).

2.11.3 Risk Models

Several authors have developed hurricane evacuation models to support management decision in case of a disaster situation.

The challenges that local authorities confront about who must decide if and when to initiate evacuations from tropical hurricanes can be decomposed into the behavior of the hurricane that is relevant to evacuation and the behavior of evacuees that is relevant to the hurricane. The uncertain behavior of these two systems can be modeled in an evacuation management decision support system (EMDSS). The hurricane EMDSS displays information about the minimum, most, and maximum probable evacuation time estimates (ETEs) in comparison to the earliest, most, and latest probable estimated times of arrival (ETAs) for storm conditions. In addition, EMDSS calculates the cost of false positive (the economic cost of an evacuation) and false negative (lives lost in a late evacuation) decision errors. EMDSS is being used in experiments to assess different information displays, team compositions, community characteristics, and hurricane scenarios. In addition, it can be used in training and actual hurricane operations (Lindell and Pratter, 2007).

Other authors develop studies that attempt to explain how particular conditions of a region, create challenges for emergency managers who must ensure that appropriate emergency plans are in place and to ensure that an orderly exodus can occur without stranding large numbers of people along an evacuation route with inadequate shelter capacity. For that, the authors conducted agent-based micro-simulations to determine the minimum clearance time needed to evacuate all residents participating in an evacuation, and the number of tourists estimated to be in the area. In addition, to estimate the number of residents that will need to be accommodated if the evacuation route becomes impassable in case a hurricane makes landfall while the evacuation is in progress (Chen, Meaker and Zhan, 2006).

Recent studies summarized evidence regarding the impacts of many variables, including risk area, evacuation notices, housing, storm threat information, hurricane probability forecasts, hurricane experience, length of residence, hurricane awareness, crying wolf, and demographics. Based on that research, it is possible to create a Katrina model that included some of the following variables (with their possible effects on predicted evacuation rates in parentheses):

- Timing of warning (weekend timing should require more people to evacuate homes).
- Amount of advance warning (should increase compliance, with the amount depending on citizens' and authorities' response capabilities).
- Condition of roads (actual and anticipated disruption should increase early evacuation, reduce late evacuation).
- Demographics (poor, urban, and elderly population should reduce evacuation and increase public shelter use).
- Degree of interagency coordination (complexity should increase actual and perceived confusion, increasing media and public skepticism, reducing compliance) (Dombroski, Fischhoff, Fischbeck, 2006).

On the other hand, some authors developed a new decision criterion in confronting extreme events introducing a measure that ranks risks in a more realistic way, since it captures aspects of the decision maker's optimism and pessimism without disregarding the expected utility approach. In particular, the new decision rule yields a weighted average of the expected utility of an act and its maximal and minimal outcomes. As an example, these researches considered the case of Hurricane Katrina and the Coast 2050 Plan, which summarized an 18-month effort by academia, private industry, and local, state, and federal agencies to develop a strategic plan to save the Louisiana costal wetlands (Basili, 2006).

2.11.4 Victims Behaviors in Disasters

Predicting human behavior in any situation is an extremely complex task which becomes harder in times of emergency. On the other hand, in order to develop hurricane evacuation plans, emergency management officials need to put more effort into predicting the response of residents, to a hurricane threat in their area. Because actual evacuation data are not available for most locations, behavioral studies have been used to predict the response of the population to a hurricane evacuation order (Nelson et al., 1989).

These authors considered five methodological issues in behavioral studies: differences between what people say they will do and what they actually do; population under study; the effect of population mobility and growth on the predictions; the effect of time and history on predictions; and the issue of "shadow evacuation" (people who are not in the danger area but choose to evacuate) (Nelson et al., 1989).

From a variety of studies, four variables can be extracted as important behavioral predictors: percentage of respondents who state they would not evacuate if ordered to do so; type of refuge indicated by potential evacuees; place of refuge of potential evacuees; and evacuation response times of potential evacuees (Nelson et al., 1989).

Therefore, it can be established that many people do in fact leave an area when requested to do so. However, it is also likely that some people will not evacuate. These individuals will ignore warnings, potential risks, and requests for evacuation. Such people often require rescue during flooding incidents. In addition, the expected number of people needing shelters is often overestimated; many responding organizations set up and operate shelters after the disaster. However, most victims will not use them. Evacuees tend to stay in hotels or visit friends and relatives. They prefer to stay in comfortable accommodations with people they are familiar with. In fact, some people stay in hotels rather than shelters. They are subsequently surprised when they find out the federal government will not reimburse them for their hotel stay. Hurricane Katrina disaster clearly illustrated these points (McEntire D, 2006).

A study made by Burnside in 2006 established that the following factors impact the hurricane evacuation behavior of New Orleans residents:

- The existence of black officials in a majority black city appears to produce higher evacuation rates for black residents.

- Storm explicit information was the most significant consideration in the evacuation decision-making process.

- There were no considerable changes in evacuation behavior for those who had an specific evacuation plan and those who did not.

Elder et al. (2007) demonstrated that a combination of poverty and perceptions of racism and inequities influenced African Americans to not evacuate, even after reaching the stage of high threat perception.

2.12 CRITICAL FINDINGS IN THE LITERATURE REVIEW

Considering the literature review above and framing it within the subject of this research work highlighted the following concepts as key and applicable discoveries:

- As a stage of the response, the performance of disaster relief operations depends on having the right information at the right time. With the proposed model, this research aims to increase the positive results of disaster relief operations and diminish the negative side effects through the correct understanding of the system structure. A better understanding of the disaster relief system will in turn facilitate the appropriate resource allocation in such a way that disaster relief organizations can determine the right formula for satisfying the victims' immediate needs.

- The American Red Cross is in charge of one of the Emergency Support Functions in which it provides Mass Care, Disaster Housing and Human Services to the victims of an outage. For this purpose, it divides its activities into seven activity/group functions. This research work is focused on three functions of the ARC, which are Mass Care, Individual Client Services and Staff Services.

- Wassenhove in 2006 proposed the creation of an Effective Disaster Management for Humanitarian Supply Chain. This research is proposing a conceptual model that will focus on the third level or echelon of Wassenhove's effectiveness model: disaster response and the specific function of disaster relief.

- Inside the Service Quality topic there are 19 models which explained the different approaches given for several authors throughout history. For the establishment of relationships between variables needed for the construction of the conceptual model, some of the constructs proposed by these authors, will be employed in six models. The extracted constructs obtained for each one of these authors are explained next:

  - ✓ Grönroos model: Service quality construct is going to be used inside the system dynamics model since the Client's Perception will be evaluated as part of the relief operation process.

  - ✓ Gap model by Parasuraman: For the construction of the conceptual model, some constructs are needed to establish relationships between variables, such as Gap 2, where Service quality strategy outlines methods for organizations to position the essential quality dimensions it wants to compete with.

- ✓ Haywood-Farmer model: This illustrates the basic service attributes, such as people's behavior, which will be used in the definition of variables and relationships between them within the model.

- ✓ In the conceptual model, it is necessary to identify the dimensions linked to service quality. It is in the Brogowicz et al. model that defines elements, such as external influences, and the effect they made in the clients service perceptions.

- ✓ The Spreng and Mackoy model: The relationships which can be established among perceived performance, overall service quality, and satisfaction for emergency relief system performance evaluation were a vital component of the conceptual model.

- ✓ Dabholkar et al. model: Comfort constructs were considered in the conceptual model as a component of the relationship of customer satisfaction with behavioral intentions which will be a key element that can be associated to the service quality factor.

- System Dynamics suggests an effective method for the comprehension of the complex dynamic process, where multiple factors evolve over time. With the construction of the Service Quality Response Cycle (SQRC) Model this goal can be performed and the mapping of the process of interdependence between resource allocation and human service satisfaction and hypothesize key mechanisms that can be developed to govern this relationship.

- The analysis of several risk models presented in the vast quantity of literature allows the understanding of several features always present in an evacuation process such as evacuation time, hurricane behavior, community characteristics, psychological variables and social factors.

- Simonovic and Ahmad, simulated the human behavior during evacuation in response to a disaster warning. These authors considered psychological factors to define the evacuation decision-making process. Therefore, evacuation orders were considered a factor that can promote an evacuation decision.

- Simonovic and Ahmad Model captures specific characteristics of the evacuation process, during a flood emergency, based on feedback loops that generate the human behavior. SQRC shows the effect of the satisfaction loop in the analysis of a disaster relief operation in case of a hurricane strike.

3 METHODOLOGY

"If A equals success, then the formula is _ A = _ X + _ Y + _ Z. _ X is work. _ Y is play. _ Z is keep your mouth shut".

-- Albert Einstein --

This chapter discusses the steps that lead this research work to the development, build and evaluation of a system dynamic resource allocation model for disaster relief operations. Relationships among variables, dimension and components are shown in the general conceptual model and boundaries were established to enclose it to a specific scope.

This chapter is organized as follows: Section 1, presents a brief review of the previous steps followed in order to obtain the necessary knowledge to develop the research mental model; Section 2, describes the activities performed by the American Red Cross; Section 3, explains the conceptual model based on the most relevant concepts found in the literature review performed in chapter 2, showing associations between variables in a general structure; Section 4, discusses the system dynamic methodology to develop the model; Section 5, describes the data preparation and identification of probability relationships and patterns; Section 6, explains the key variables in the Katrina operation estimated by "other sources"; Sections 7, 8 and 9, present an overview of issues related to sources and analysis of data such as cleaning; data mining process and CHAID analysis, and graphical representations are exhibited respectively. Section 10, presents the mapping system structure; Section 11, explains the equation definition process.

3.1 PREVIOUS STEPS

At the beginning of this study several questions and queries about disaster relief operations were made in order to explore the dynamics of this kind of process. Therefore a research problem was outlined and objectives to be pursued were described as a way to solve the delineated questions.

A literature review was conducted with the aim of examining what topics authors have worked in, related to this research work, such as, disaster preparedness, relief systems, disaster relief organizations, customer satisfaction, resource allocation, service quality, system dynamics, data mining and the relationships among them.

The first action taken was to develop a mental model as part of the knowledge construction of the research problem. As is exhibited in Figures 19 and 20 several additional steps are needed to build the proposed model. The noted steps are explained in the following sections.

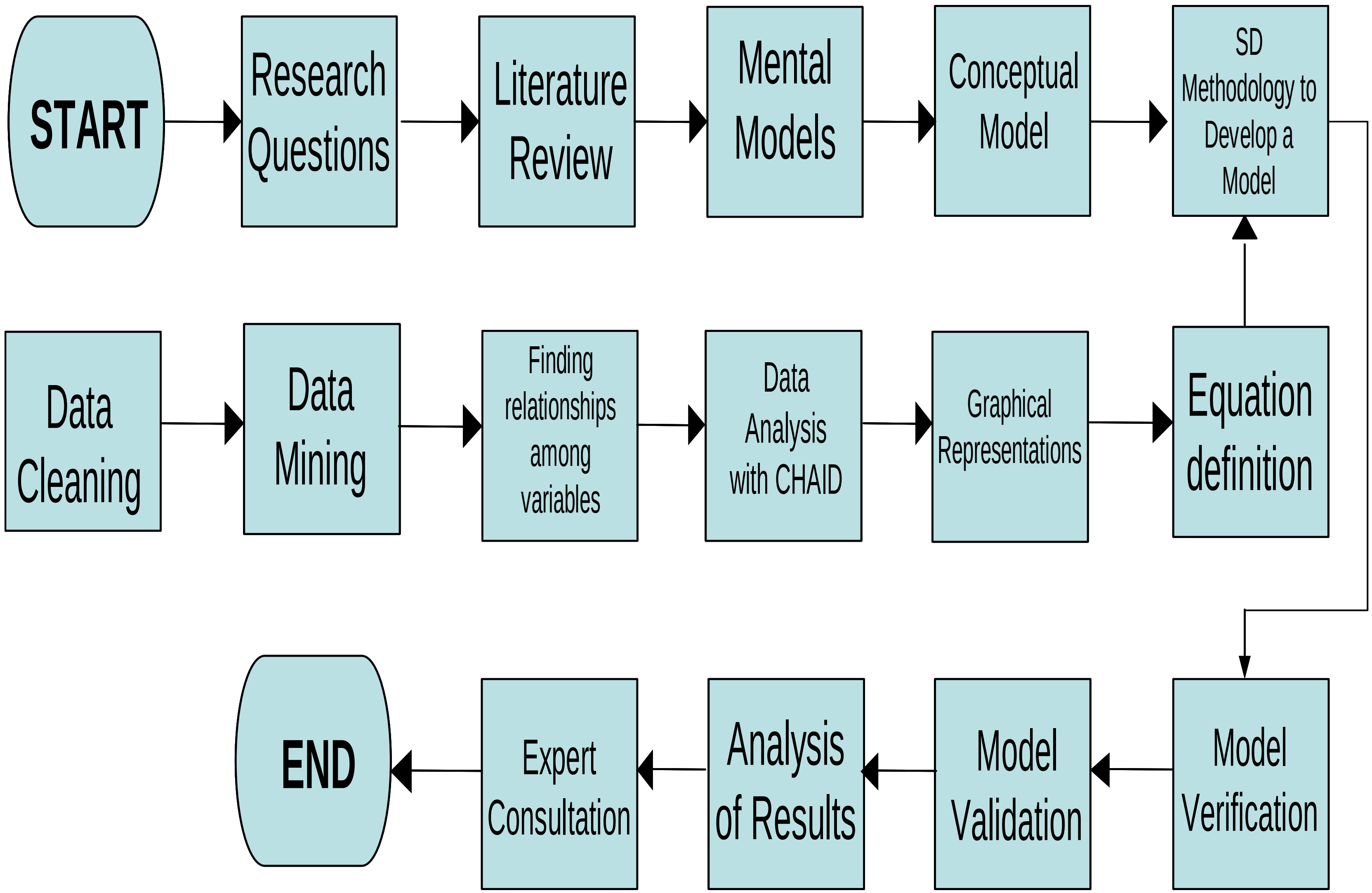


Figure 19. Methodology Flowchart. Author's Elaboration, 2007.

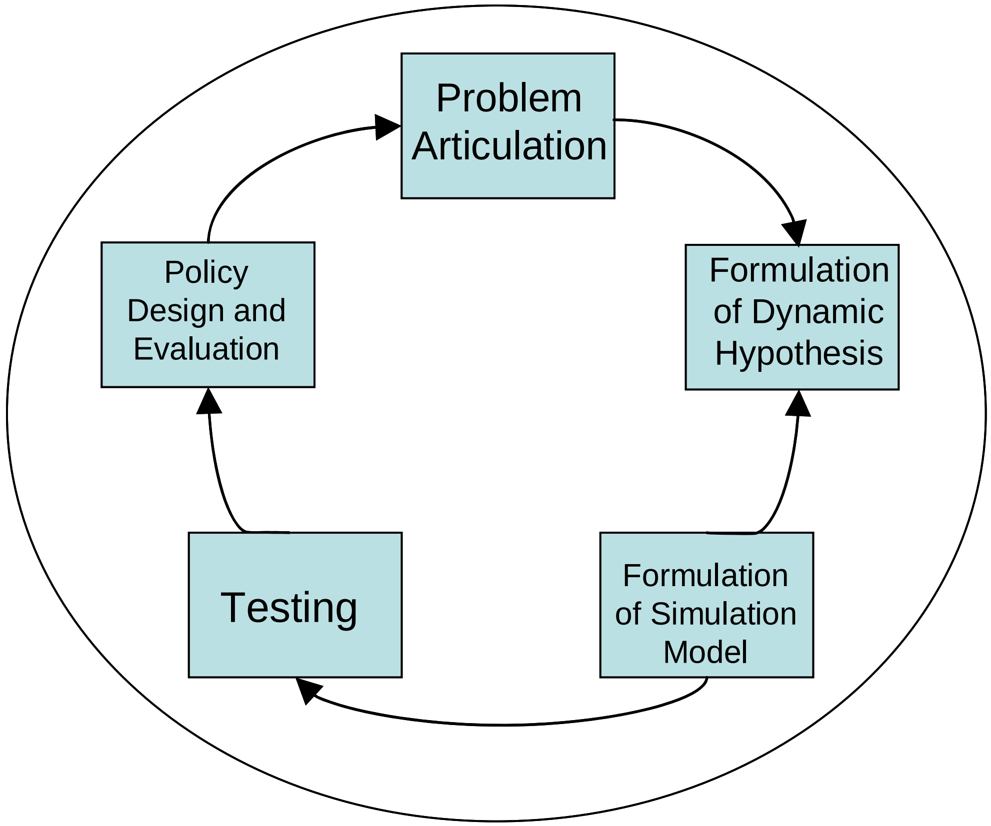


Figure 20. SD Methodology to Develop a Model. Sterman, 2000.

3.2 NONPROFIT DISASTER RESPONSE

To succeed in Disaster Relief Operations the American Red Cross organizes its activities in units to produce winning results. Each unit of the disaster relief operation is responsible either for satisfying a division or for supporting another unit that is providing services.

Disaster relief operation personnel are organized under the Disaster Services Human Resources system group/activity structure. Employees and volunteers are assigned to work in groups, depending on their individual competencies (The American Red Cross, 2006). The activities are described next:

- **Mass Care:** Services provided on a congregate basis to the community as a whole, such as sheltering, feeding and bulk distribution of items, including information about the availability of these services and recovery information.

- **Individual Client Services:** Services provided through caseworkers to individual victims of disaster, including direct financial assistance for replacement of essential items, counseling services, health-related services and reunification or welfare information services.

- **Partner Services:** Coordination and liaison among government and private agencies and organizations and the affected communities for the benefit of disaster victims.

- **Staff Services:** Services that help Red Cross employees and volunteers, including spontaneous volunteers, meet the needs of the people and communities affected by a disaster. These services include travel, housing, physical and mental health care, training, job placement, staff relations, performance management, personnel counseling and safety and security.

- **Material Support Services:** Support services necessary to conduct a disaster relief operation, including securing the facilities, supplies and equipment required for an effective response.

- **Information Management Support Services:** Assessment and operational data required to manage the response, including information about the scope of the disaster and the effectiveness of the response. This information is used in reports to donors about the effective use of their contributions to the Red Cross.

- **Organization Support Services:** Other Red Cross services that support disaster response and relief operations, such as raising funds and accounting for the funds used to provide services (The American Red Cross, 2006).

Each of the mentioned activities has been grouped together according to seven groups in the Disaster Services Human Resources system. Three of these, Mass Care, Individual Client Services and Staff Services are taken into account as key variables in this model for this research work (see Figure 21).

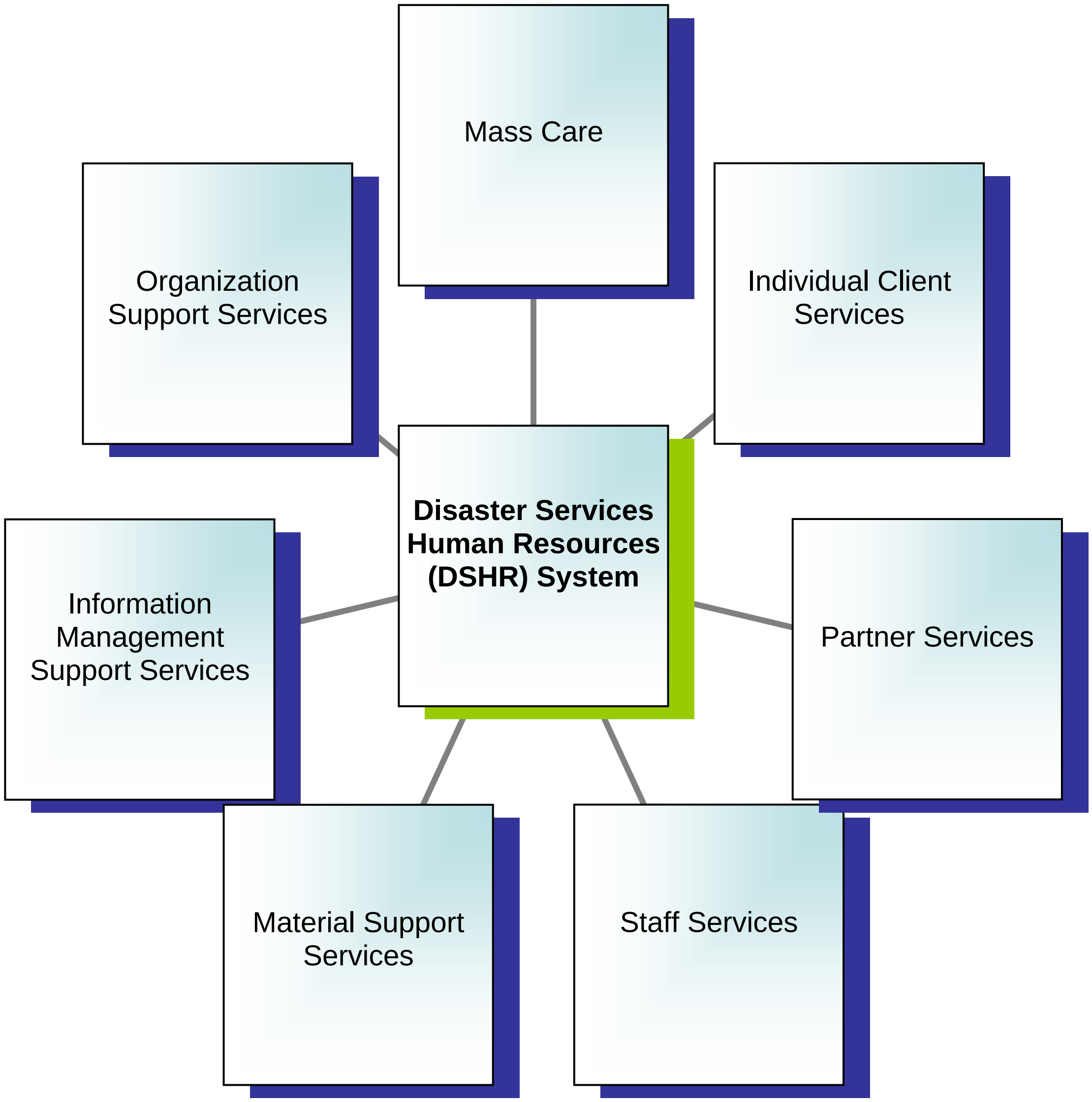


Figure 21. Disaster Services Human Resources System Group/Activity Structure. Author's Elaboration, 2007.

With the interaction of these Group/Activities the DSHR System enables the Red Cross to provide disaster relief services to the American people in a prompt and efficient way.

3.2.1 Reducing the Scope

Based on the above and the portions of the system that have direct interaction with the victim thus influencing his/her perceptions of the service, the scope of the research project was reduced. Besides the interaction with other subsystems, just three functions of the disaster response cycle, Mass Care, Individual Client Services and Staff Services were included in this study (see Figure 31). Only one element of the disaster response cycle, Relief, and one subsystem of the same, the emergency relief performance subsystem, was taken into account.

The choosing of the mass care function was made for the purpose of showing what resources are needed during a relief operation to assist people, and measure their satisfaction of the service provided to them. With the information included in the databases provided by the American Red Cross, such as the Katrina Panel database, FOCIS and ENVIRONMENT database, the Full Katrina Data Set and the Disaster Operations Summary Reports it was possible to incorporate the information about the services given to the community such as sheltering, feeding and bulk distribution of items.

The choosing of the Individual client services function was made with the purpose of showing what financial assistance is needed during a relief operation to assist people and measure their satisfaction of the aid provided to them. The establishment of these financial resources, it is possible to do it throughout the opening of cases made during the casework process. With the information included in the Full Katrina Data Set it was possible to incorporate the information concerning the financial services given to the community.

The choosing of the Staff Services function was made with the purpose of showing what mental health care activities and services are necessary to meet the needs of the people and communities affected by the disaster. These activities are executed by ARC employees and volunteers. With the information included in the Disaster Operation Summary Report it was possible to incorporate the information about the staff services given to the community.

The Service Quality Response Cycle (SQRC) can cover a wide variety of emergency/disaster events, either natural or man-made and could inform resource allocation during the relief operation. The model delineated for this particular research however, was developed for Hurricane emergencies.

3.3 THE CONCEPTUAL MODEL

System definition of the proposed model was provided in chapter 1 and the dynamics observed from the interactions between components and variables. The conceptual model captures the essential concepts of the emergency relief system (e.g. function, system, and requirement) in the form of an information model which is expressed as a composite structure diagram including the interactions point of the elements of the other part of the system.

3.4 METHODOLOGY TO DEVELOP A SYSTEM DYNAMICS MODEL

With modeling, it is possible to formulate hypotheses, test and review them for formal and mental models (Sterman, 2000). To build up the new model that incorporates the victim's intentions and perceptions of service quality in a disaster relief operation and the interrelation with resource availability it is necessary to determine several chronological steps. The mentioned steps are explained in the following sections.

3.4.1 Problem Articulation (Boundary Selection)

This phase outlined and described the real problem of this research work keeping in mind what is enough to delimit the model. The model concentrates on a particular problem, and it is not attempting to model the whole complexity of the emergency-management system. For that reason, boundary selection was a priority task that set the limits for this complex system and a selection was made of all components. The scope of this research work is enclosed in the disaster relief operation system, more specifically, in the emergency relief system performance subsystem. Only three functions of the ARC group activity/structure: Mass Care, Individual Client Services and Staff Services are contemplated to be used. The model considers hurricane disaster events only. Therefore, the number of variables was limited to those relevant to the specific problem.

3.4.1.1 Theme Selection

In the research problem, the issue of resource-allocation decisions related to the organizational performance improvement during disaster relief operations was outlined as a service quality and resource availability dilemma. After examining reference modes, this research included in the research problem, the issue of the clients' disposition to evacuate, and the interconnected nature with the other affected community factors.

3.4.1.2 Key Observed Variables

With a clear and defined purpose, the important components of the system were defined.

The Emergency Response Cycle presented in Figure 4 shows the general action cycle followed immediately by DROs (Disaster Relief Organizations) after an event occurs and is applicable to any emergency response plan. The action phases of the Emergency Response Cycle (ERC) included in this research named as response (rescue and relief), recovery, reconstruction, mitigation and preparedness, are the general model actually applied to all the emergency-management systems.

Tables 5, 6, 7, and 8 presents the observed variables of the Service Quality Response Cycle (SQRC) established in the causal loop diagram of the system (see Figure 31). This table also describes a brief definition for each one of them and the source of the data.

These variables were chosen because they represent the underlying service provision, and the data to support these variables were available in the databases provided by the American Red Cross.

Table 5. Key Observed Variables. Author's Elaboration, 2008.

Component of SQRC	Variable Name	Definition	Data Source
Affected Community	Population Affected	Is the amount of people (lived, worked, transited) located in the disaster site when the hurricane struck.	FOCIS - Field Operations Consolidated Information Systems - and ENVIRONMENT.
	Client's Disposition for Evacuation	Conscious inclination that any individual or family has for leaving the potential disaster site.	• KPD- Katrina Panel Data. • ICP2-Indicators of Chapters Performance and Potentials. • FKDS, Full Katrina Data Set.
	Evacuated Population	Is the quantity of people displaced from the disaster site.	KPD- Katrina Panel Data.
	People in Shelter	Is the amount of people that went to refugees looking for temporary housing and protection.	Disaster Operations Summary Report.
System Capacity	Opened Shelters	Is the number of refugees opened to provide protection or temporary housing to the community affected by the hurricane disaster.	Disaster Operations Summary Report.
	Opened Cases	Is the number of records that describes a disaster, crystallizes the disaster victims' needs and describes the Red Cross response (The American Red Cross, 2006).	Disaster Operations Summary Report.
	Served Meals	Amount of mass feeding provided to minimize immediate disaster caused needs (The American Red Cross, 2006).	Disaster Operations Summary Report
	Financial Assistance	The funds provided by the American Red Cross for disaster relief.	FKDS, Full Katrina Data Set.
	Mental Health Care	Care required for an emotional or behavioral problem for the disaster victims (The American Red Cross, 2006).	FKDS, Full Katrina Data Set.
	Staff Availability	The accessibility of staff resources in a timely manner.	Disaster Operations Summary Report.

Table 6. Key Observed Variables. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Data Source
System Capacity	Staff Capacity	The maximum possible amount of Red Cross employees and volunteers employed by the American Red Cross, in a disaster relief operation.	**NA**
	New Volunteers	Additional people who perform a voluntary relief service for the ARC.	**NA**
	Volunteers Trained	Additional people with specialized instruction and practice, in relief operation.	**NA**
	DSHR (Disaster Services Human Resource) Capacity	Amount of resources stored and distributed by the American Red Cross with the aim of help - the personnel and human resources management system to meet its human resources requirements in response to disaster. Red Cross employees and volunteers that are qualified and available to be assigned to disaster relief operations are eligible to be enrolled in this system. The DSHR System enables the Red Cross to provide prompt and efficient disaster relief services to the American people. It is an integrated and consistent approach to managing the workforce over the long term using a common set of competencies that are linked to business strategies and results (The American Red Cross, 2006).	**Disaster Operations Summary Report**
	Mass Care Capacity	Total services provided on a congregate basis to the community as a whole, in terms of sheltering and feeding.	**Disaster Operations Summary Report**
	Individual Client Services Capacity	Total services provided through caseworkers to individual victims of disaster, including direct financial assistance for replacement of essential items.	**Disaster Operations Summary Report**
	Staff Services Capacity	Total Services help through which Red Cross employees and volunteers meet the needs of mental health care of the people and communities affected by a disaster.	**Disaster Operations Summary Report**
Emergency Relief System Performance	**Needs Met**	**Actions through those disaster clients' requirements, conditions and situations are satisfied during the Relief stage of the Response Function.**	• **KPD- Katrina Panel Data.** • **ICP2-Indicators of Chapters Performance and Potentials.** • **FKDS, Full Katrina Data Set.**

Table 7. Key Observed Variables. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Data Source
Emergency Relief System Performance	Client's Perceptions ARC Service	What a client identifies for a given service.	• **KPD- Katrina Panel Data.** • **ICP2-Indicators of Chapters Performance and Potentials.** • **FKDS, Full Katrina Data Set.**
	Total Service Quality Perception	Is the existence break between both Perceived and Expected Benefits	• **ICP2-Indicators of Chapters Performance and Potentials.** • **FKDS, Full Katrina Data Set.**
	Client's Satisfaction	Proportion of clients that before, during and after the emergency event developed feelings of satisfaction.	• **FKDS, Full Katrina Data Set.**
	Goal for Satisfaction	The purpose toward which the endeavor of the ARC service provided is directed: to convert the performance gap to zero.	**NA**
	Cash Donations	Is a form of gift to a fund or cause, typically for charitable reasons (Wikipedia).	**Disaster Operations Summary Report.**
	Resources Available	Are the existing sources of the American Red Cross used to disaster relief.	**Disaster Operations Summary Report.**
	Resources Stored	Sources accumulated by the ARC until needed.	**NA**
External Factors	**Client's Profile**	**A summary of any individual or family in terms of a number of relevant parameters such as: Realty owners.**	• **KPD- Katrina Panel Data.** • **ICP2-Indicators of Chapters Performance and Potentials.** • **FKDS, Full Katrina Data Set.**

Table 8. Key Observed Variables. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Data Source
External Factors	Demographic Characteristic	Typically involves household income and race (Wikipedia).	• **KPD- Katrina Panel Data.** • **ICP2-Indicators of Chapters Performance and Potentials.** • **FKDS, Full Katrina Data Set.**
	Hurricane Level	The categories into which the Saffir-Simpson Hurricane Scale classifies hurricanes. They are distinguished by the intensities of their respective sustained winds. The classifications are intended primarily for use in measuring the potential damage and flooding a hurricane will cause upon landfall (Wikipedia).	**Disaster Operations Summary Report**
	Media	Is the generic term for print (Newspapers, magazines, etc) and electronic (radio and television) communication devices used for advertising (Learnthat).	**The New York Times News**
	Public Opinion	**Is the aggregate of individual attitudes or beliefs held by the adult population (Wikipedia).**	**The New York Times News**

In the definition of the SQRC scope, there is a list of concepts that were excluded from the model. These concepts are presented below:

- Partner Services.
- Material Support Services.
- Information Management Support Services.
- Organization Support Services.

This list provides significant warnings to the model user. The model omitted four of seven DSHR Groups activities. These excluded variables allowed the understanding of the integrated approach to managing the workforce over the long term using a set of competencies related to liaison activities with other agencies (Partner Services), facilities and equipment (Material Support services), assessment and operational data (Information Management Support Services), and raising funds (Organization Support Services). The purpose of listing all these omissions is to help the model users decide whether the model was appropriate for their purpose.

3.4.1.3 Time Horizon

The time horizon of this research is explicitly stated. Katrina operation was 27 days long. It showed how the problem emerged and described its symptoms. The data source is detailed in the data cleaning section.

Timeline of the Hurricane Katrina

Below, a brief description is provided for the chronological events that followed after Hurricane Katrina struck (see Figure 22).

- **Day 1, August 28:** It was only 24 hours before the hurricane struck that a mandatory order to evacuate the city was made (Cabinet Office Civil Contingencies Secretariat, 2006).

- **Day 2, August 29:** Hurricane Katrina hit the States of Alabama, Mississippi and Louisiana. The storm took all day to pass through the area. The ARC began to open more shelters to provide protection and temporary housing to the affected population.

  As a consequence of the hurricane pass, there was complete loss of communications, radio masts were blown down and the cell phone network overloaded and crashed. Call centers were knocked out disrupting local emergency services, and customer phone lines were knocked out in Louisiana, Alabama, and Mississippi. Broadcast communications were also affected (Cabinet Office Civil Contingencies Secretariat, 2006).

- **Day 4, August 31:** Eighty percent of New Orleans was flooded, with some parts under 15 feet of water. Most of the city's levees designed and built by the United States Army Corps of Engineers were breached (Wikipedia).

- **Day 5, September 01:** During this day people began to leave the shelters.

- **Day 7, September 03:** The National Guard evacuated the Superdome and the Convention Centre (Cabinet Office Civil Contingencies Secretariat, 2006).

- **Day 10, September 06:** Reports of rape, murder and beatings in Houston Astrodome were announced in the news (Boingboing A Directory of Wonderful Things).

- **Day 11, September 07:** More DSHR were deployed to the disaster site.

- **Day 12, September 08:** Many of those evacuated from the Superdome in Louisiana found refuge in the Reliant Park Centre in Houston (Cabinet Office Civil Contingencies Secretariat, 2006).

  During this day shelters began to close down and DSHR began to open cases.

- **Day 24, September 20:** Tropical storm Rita has been upgraded to a hurricane. During this day shelters began to re-open.

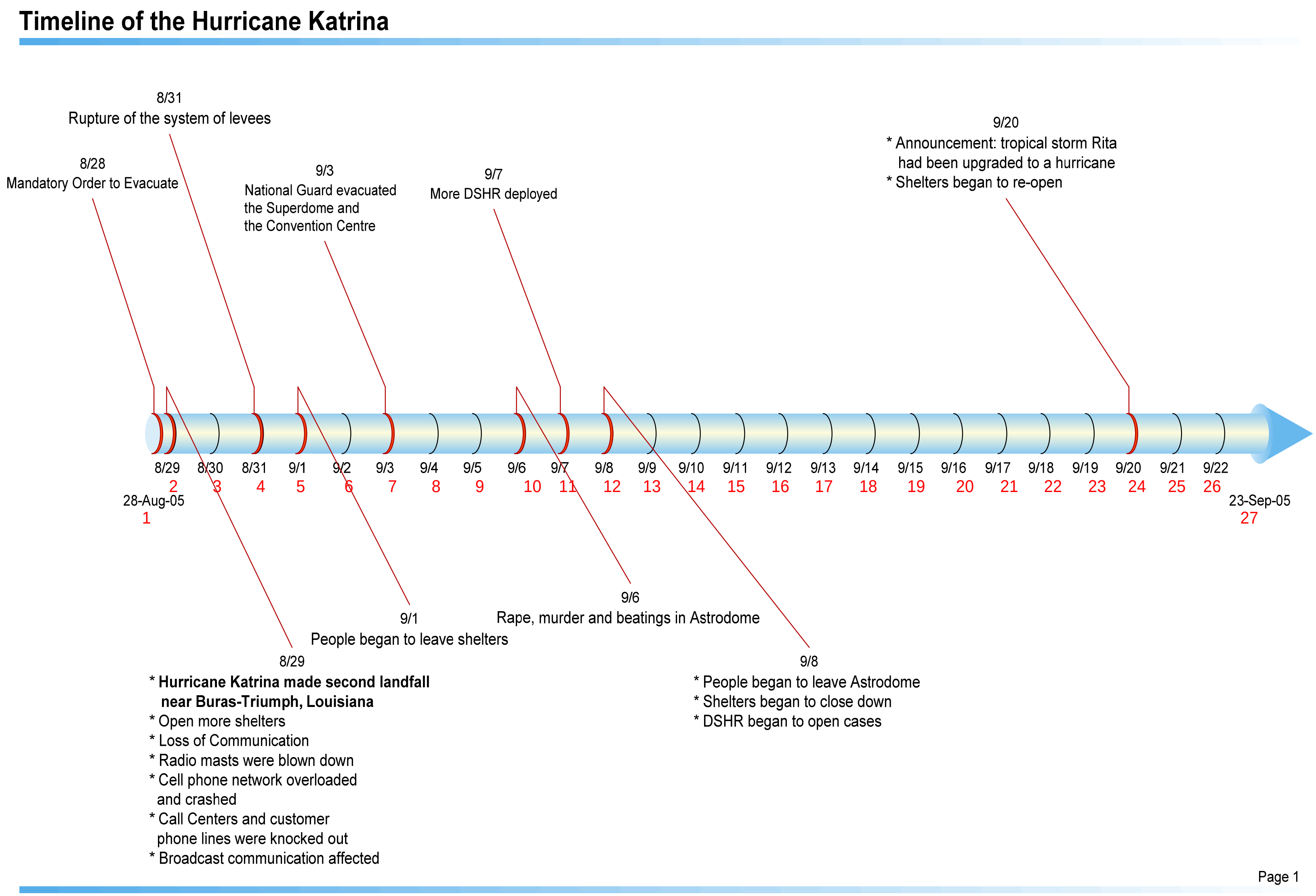


Figure 22. Timeline of the Hurricane Katrina. Author’s Elaboration, 2008.

3.4.1.4 Dynamic Problem Definition (Reference Modes)

Reference modes were drawn related to the pattern of behavior for key variables over time (Sterman, 2000). With these modes, it was possible to clarify, analyze past and future behavior in an explicit labeled time, and limit the problem statement.

The following graphs illustrate the chosen reference modes for this problem. They translate the behavior of the system into a graphical form. They were selected as the most relevant concepts for understanding the research problem and the design of the policies to solve it. Data for these reference modes are based on American Red Cross of pre and post Katrina Hurricane disaster (see Figure 23, Figure 24, Figure 25, Figure 26, Figure 27, Figure 28 and Figure 29).

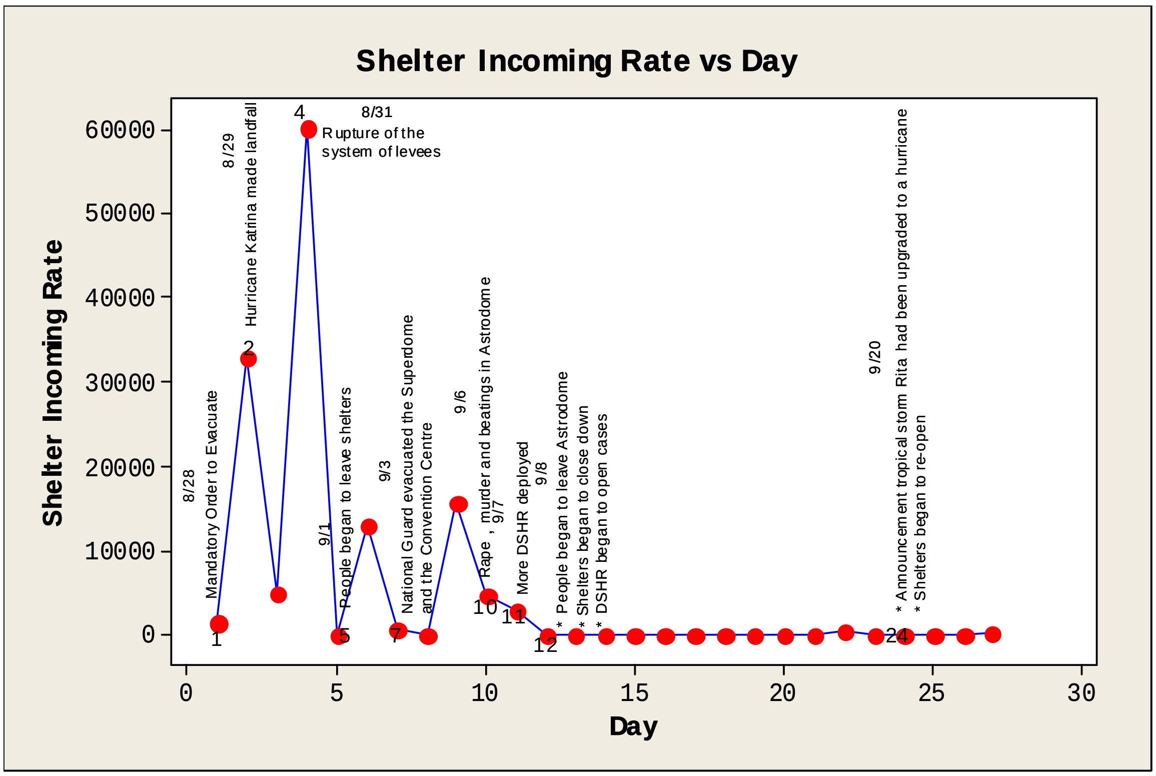


Figure 23. “Shelter Incoming Rate” during Katrina Operation. Author’s Elaboration, 2008.

It is clearly visible a large fluctuation with peaks appears around the 2^{nd} and 4^{th} day. Shelter incoming rate has ranged from 0 to nearly 60,098 people.

This reference mode follows a chaotic oscillations behavior. This means that the system fluctuates irregularly. This irregularity arises endogenously and never exactly repeats (Sterman 2000).

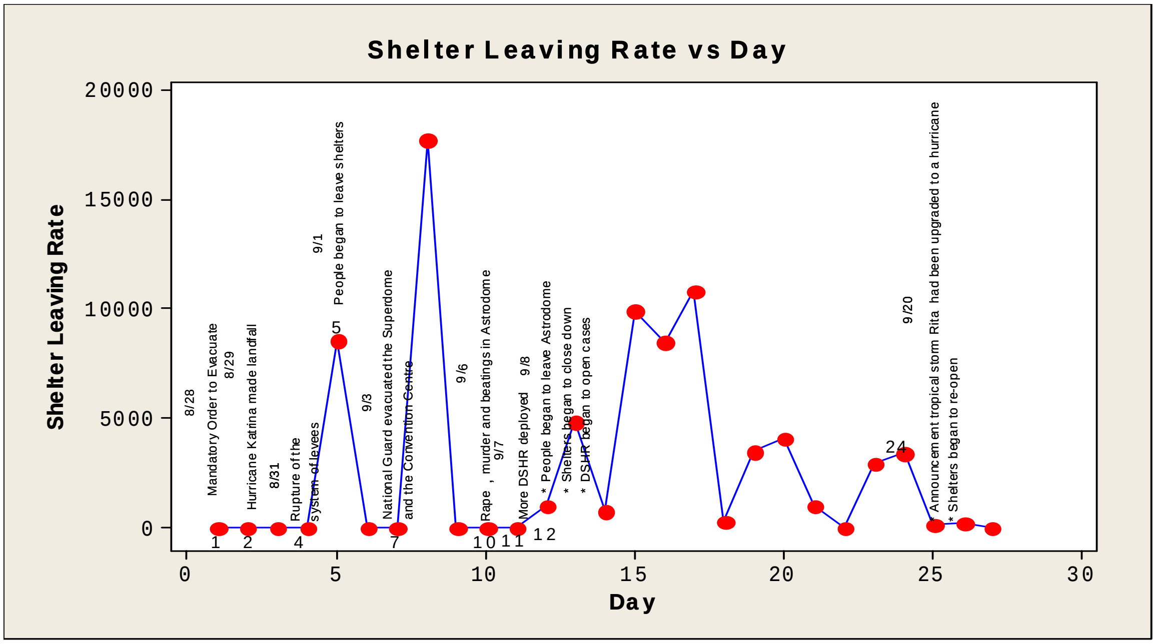


Figure 24. "Shelter Leaving Rate" during Katrina Operation. Author's Elaboration, 2008.

It is clearly visible a large fluctuation with peaks appears around the 5th and 8th day. Shelter leaving rate has ranged from 0 to nearly 17,784 people. This reference mode follows a chaotic oscillations behavior (Sterman 2000).

The rate of people entering and leaving the shelters reference modes provides information on the number of resources to be needed in the disaster relief operation to assist these hurricane victims.

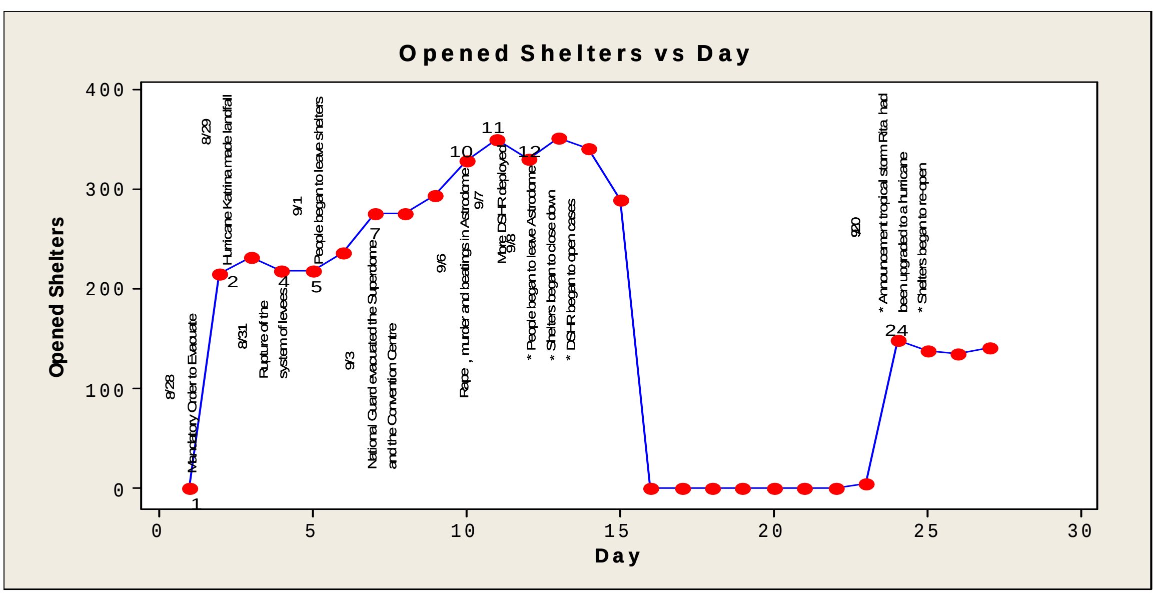


Figure 25. "Opened Shelters" during Katrina Operation. Author's Elaboration, 2008.

It is clearly visible that there is a large fluctuation with peaks appearing around the 11th and 13th day. Opened Shelters ranged from 0 to nearly 352 units. This reference mode follows an overshoot and collapse behavior (Sterman 2000).

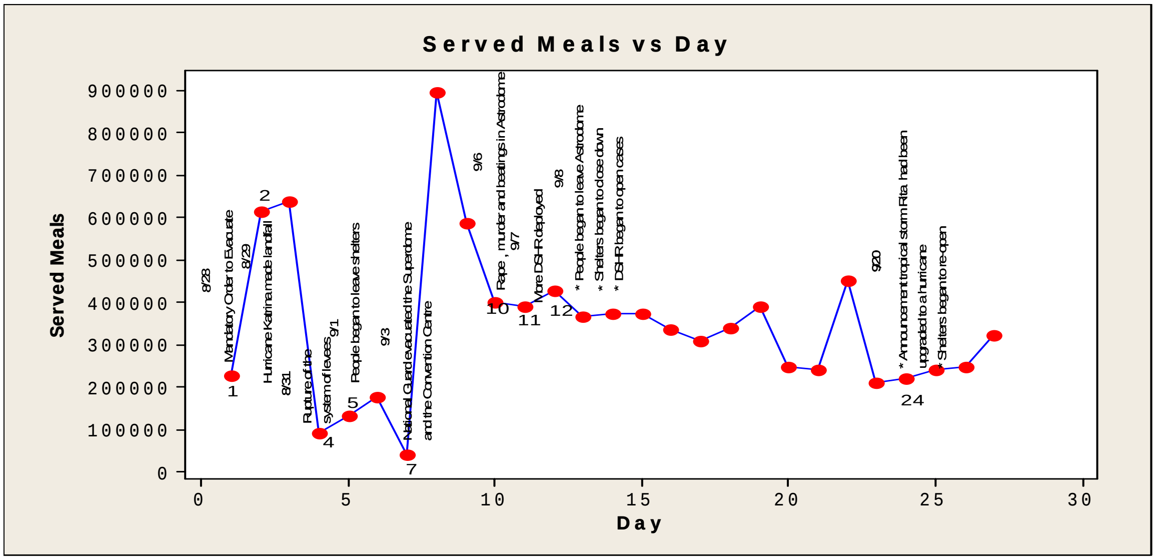


Figure 26. “Served Meals” during Katrina Operation. Author’s Elaboration, 2008.

It is clearly visible that there is a large fluctuation with peaks appearing around the 3rd and 8th day. Served Meals ranged from 0 to nearly 895,303 units. This reference mode follows a chaotic oscillations behavior (Sterman 2000).

“Opened Shelters” and “Served Meals” reference modes provide information with which it can be possible to forecast what should be stored in advance in preparation for a potential emergency.

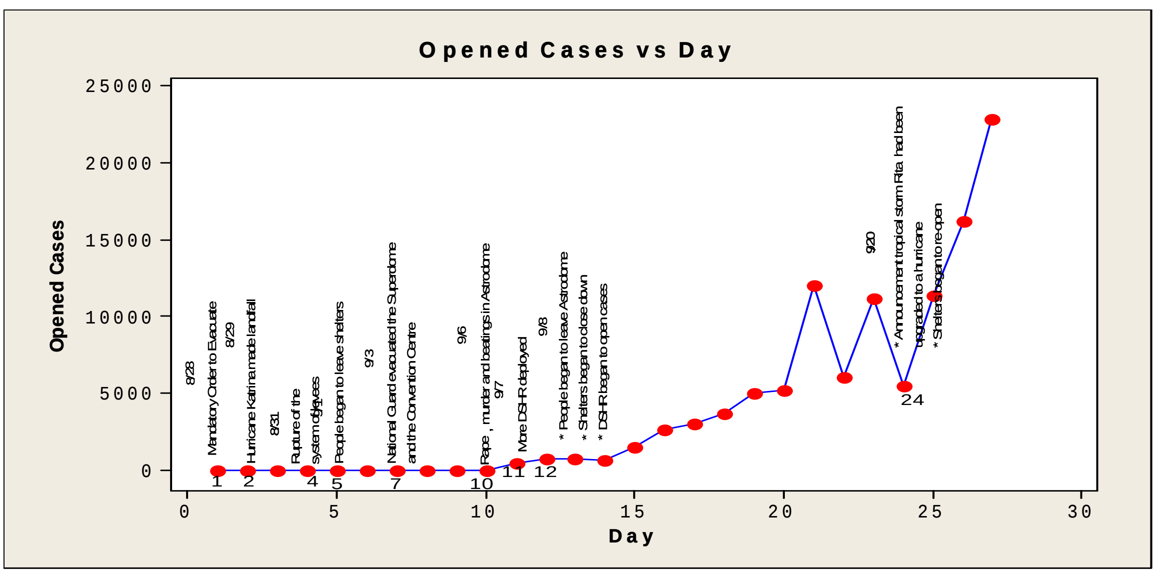


Figure 27. “Opened Cases” during Katrina Operation. Author’s Elaboration, 2008.

It is clearly visible, that there is a large fluctuation with peaks appearing around the 26th and 27th day. Opened Cases ranged from 0 to nearly 22,755 cases. This reference mode follows an oscillation behavior (Sterman 2000).

"Opened Cases" reference mode provides information with which it can be possible to forecast what should be the kind of resource-allocation decisions these organizations can make to satisfy clients' needs.

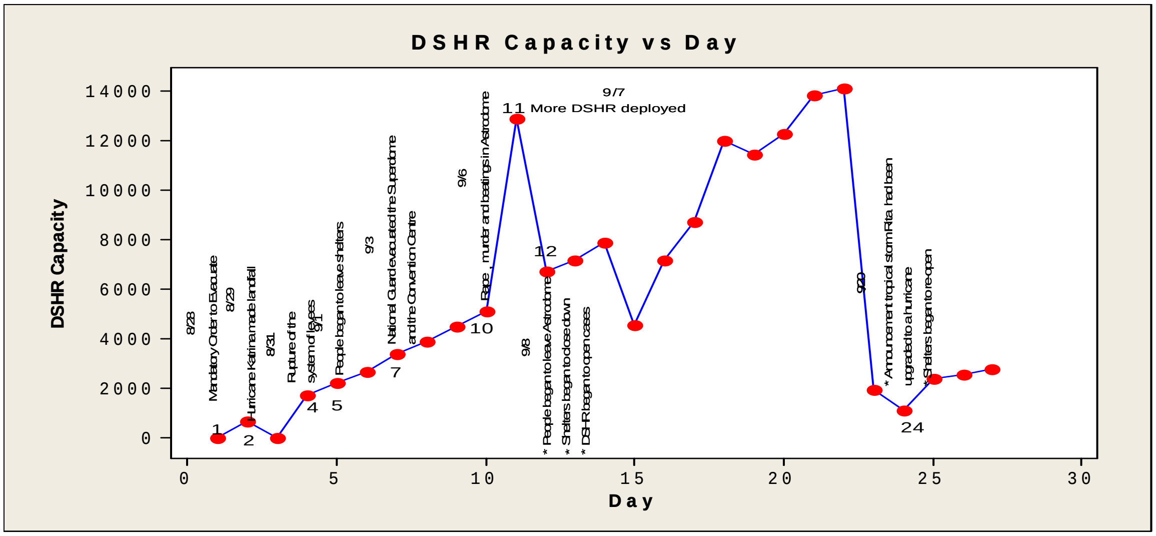


Figure 28. "Deployed DSHR" during Katrina Operation. Author's Elaboration, 2008.

It is clearly visible, that there is a larger fluctuation with peaks appearing around the 21st and 22nd day. Deployed DSHR ranged from 0 to nearly 14,067 people. This reference mode follows an overshoot and collapse behavior (Sterman 2000).

DSHR reference mode provides information about the service provider human resources with which it can be possible to forecast what would be the human resources required in advance in preparation for a potential emergency.

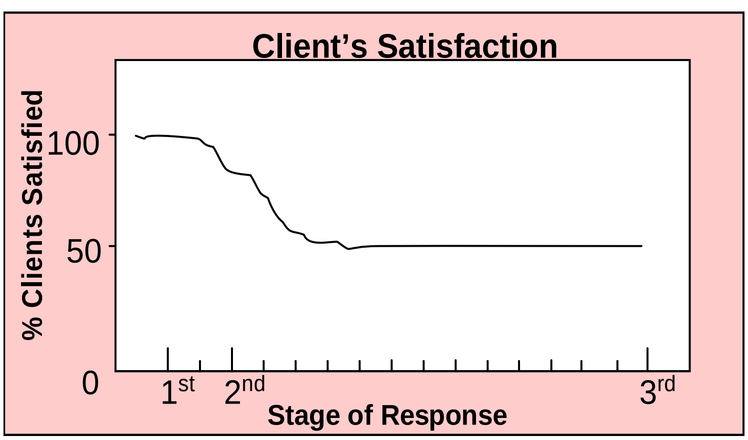


Figure 29. "Client's Satisfaction" during Katrina Operation. Author's Elaboration, 2008.

This reference mode exhibits a pure negative exponential goal-seeking (also called exponential decay) behavior (Sterman 2000).

This behavior was assumed because there is a concern of how to capture the information related to the clients' satisfaction. Although the FKDS database embraces this information for each stage of operation, it is impossible to attach it with the number of days of response operation, because this information is specified in the KPD database. Therefore, the two databases correspond to a different kind of sample population.

The assumed behavior was determined after the analysis of the news and reports on the Internet about the assistance provided by the American Red Cross during the relief operation.

On the 1st day, a mandatory order to evacuate the city was made.

The higher rate of people that went to the shelters, in the early phase of relief, occurred: in the 2nd day of operation, because that was the day Hurricane Katrina struck New Orleans; and in the 4th day when the system of levees broke. Therefore, more shelters began to open.

People went to shelters during the first 11 days of the response operation. Some of them began to leave on the fifth day and the rest of them began to leave on the 12th day. It means that in general some of the population spent four days in the shelter and the rest of them 11 days. This statistic can be confirmed with the multiple response analysis made in SPSS (see appendix E).

On the 12th day, shelters began to close down, but they began to re-open on the 24th day. That behavior corresponds to the announcement made by the weather news on the 24th day, that tropical storm Rita had been upgraded to a hurricane.

Therefore, the number of "Served Meals" was tied to the number of people in the shelter at that time. From the 24th day, the number of meals began to increase, due to the announcement of Rita.

In addition, the number of "Opened Cases" was a function of the number of people leaving the shelter and of the DSHR deployed. People began to leave the shelters on the 12th day, because they were waiting for the DSHR to open the cases to provide them with financial aid. Therefore, the rate at which people left the shelters depends on the rate that cases were opened. From the 25th day, the number of cases began to increase, due to the announcement of Rita.

The DSHR deployed during the Katrina operation were a function of the number of people incoming and leaving the shelters. From the 25th day, the number of DSHR deployed began to increase, due to Rita approaching. There was an increment in the number of DSHR deployed on the 11th day. The reason could have been the reports of rape, murder, and beating in Astrodome, made by the evacuees to the news the day before.

There was a delay in the deployment of the DSHR at the beginning of the relief operation. That was due to the training needed for the DSHR personal to be deployed to the relief operation.

3.4.2 Formulation of Dynamic Hypothesis

With this step and understanding of the mapping structure of the system, it was established how the models work. The next steps must be followed to complete this phase.

3.4.2.1 Endogenous Focus

System Dynamics seeks endogenous explanation for phenomena rather than exogenous ones. According to Sterman (2000), explanations based on exogenous variables are not of much interest because they explain the dynamics of interest variables in terms of other variables whose behavior is assumed.

Exogenous variables are those outside the system and they are not affected dynamically by interactions and feedbacks between the variables inside the system.

Three dynamic hypothesis were formulated to explain the reference mode behavior and should be consistent with the model's purpose. The three dynamic hypotheses for this research are:

- Given that the amount of resources necessary to meet the needs of the victims depends on the number of victims left by the natural disaster in need for help, then an increment in the capabilities of the system and resources available (served meals, delivered financial assistance and DSHR capacity for the recovery of the victims) would increase the perception of the quality of service provided to the evacuated clients at each stage of the relief operation. This satisfaction then will be greatly affected by the timeliness of deployment of those resources.

- Poor service provided by DSHR to the evacuated clients during the response operation, was defined by long waits to be served, resulting in a negative impact on the client's satisfaction. The level of attention provided to the people in shelters, and the rate of reporting and opening of cases during and after the event depends on the amount of DSHR deployed for this response operation. Then, the number of DSHR deployed is the key element in the development of this operation. Deploying few DSHR has the ability to diminish the system performance more than any other element.

- The disposition for evacuation that clients had, at this point in the hurricane event, depend on their demographic characteristics and profile. In turn, the number of people that evacuated. A sudden increment in the number of people that go to the shelters will require larger numbers of trained staff and volunteers need to be ready for deployment in anticipation.

If a model is created depicting the above hypothesis, changing the system structure could lead to a scenario analysis that would allow for the correct resource allocation, while considering the client's perception of the services received during the hurricane disaster.

3.5 DATA PREPARATION AND IDENTIFICATION OF PROBABILITIES RELATIONSHIPS AND PATTERNS

This section describes how different databases, provided by the American Red Cross, were used in a data mining exercise to find the patterns of client behavior during the Katrina operation. This in turn provided the likelihood (probabilities) of evacuation before, during or after the storm of an affected population given their demographic characteristics and other economic information (such as home ownership or not). This information was then joined with information from the census data and from FEMA databases and the media such as newspapers and other public databases. This allowed the construction of a causal diagram that was later adjusted and refined to parameterize the stock-and-flow model with parameters derived from real victims of a hurricane.

This is probably one of the main contributions of this research, as this is one of the major undertakings ever to put together pieces of information of disaster relief that researchers have tackled as separate problems to construct a dynamic framework.

Four databases were provided by the American Red Cross, and it is important to clarify that as the data come from a single source, it is impossible to conclusively generalize these findings to other organizations. The databases are detailed below:

A. **FOCIS - Field Operations Consolidated Information Systems - and ENVIRONMENT:** This set contains information related to operational data, financial data, number of volunteers, human resources, among others. Data summarized in this set have been collected since 1990.

B. **ICP2, Indicators of Chapters Performance and Potentials:** This array includes information associated with service quality, customer satisfaction, partners' opinion and agreements among others. Data recapitulated in this set have been gathered since 2002. See appendix B for questionnaire information.

C. **FKDS, Full Katrina Data Set (study performed by and independent contractor):** This set encloses information connected to client's zip code, city relocations, and clients' feelings after the outage and during each response stage, difficult experiences, and situations lived in shelters, among others. Data in this set have been collected from September until October 2005 and has a 3% of reliability. See appendix C for questionnaire information.

D. **KPD, Katrina Panel Data:** This array consists of information associated with the client's resources before the event, whether the client's pay attention to the evacuation order, among others. Data in this set have been collected since December 2005 with a 5% of reliability. See appendix A For questionnaire information.

To be analyzed, ICP2, FKDS and KPD, were categorized in one of the three following measurement levels using SPSS (Statistical Product and Service Solutions) software:

- **Nominal**, Data values represent categories with no intrinsic order (e.g., job category or company division). Nominal variables can be either string (alphanumeric) or numeric values that represent distinct categories (e.g., 1=Male, 2=Female).

- **Ordinal**: Data values represent categories with some intrinsic order (e.g., low, medium, high, strongly agree, agree, disagree, and strongly disagree). Ordinal variables can be either string (alphanumeric) or numeric values that represent distinct categories (e.g., 1=low, 2=medium, 3=high). For ordinal string variables, the alphabetic order of string values is assumed to reflect the true order of the categories.

- **Scale**: Data values are numeric values on an interval or ratio scale (e.g., age, income). Scale variables must be numeric (Information Systems Services, 2006)

FOCIS and ENVIRONMENT data contained in Excel were related through a variable which was embraced in both files. Therefore, ECODE was chosen as the own primary key and was applied referential integrity in the relational database consistency between coupled tables. Then FOCIS becomes the main table of this database.

E. **Disaster Operations Summary Report**: Additionally to these databases, disaster operations summary reports emitted during the Katrina and Rita operations were analyzed and condensed in an Access database. The information was classified in Excel for each day of operation depending on the date, source and destiny of the resources, service area and material and human resources.

Once the information was extracted from the ARC reports and quantified in an excel file, this was used adding it to the Access database with FOCIS and ENVIRONMENT data. As a result, Service Area was chosen as a primary key and applied referential integrity to the relational database consistency between fundraising, partner, calls, volunteers, events and FOCIS tables (see Figure 30).

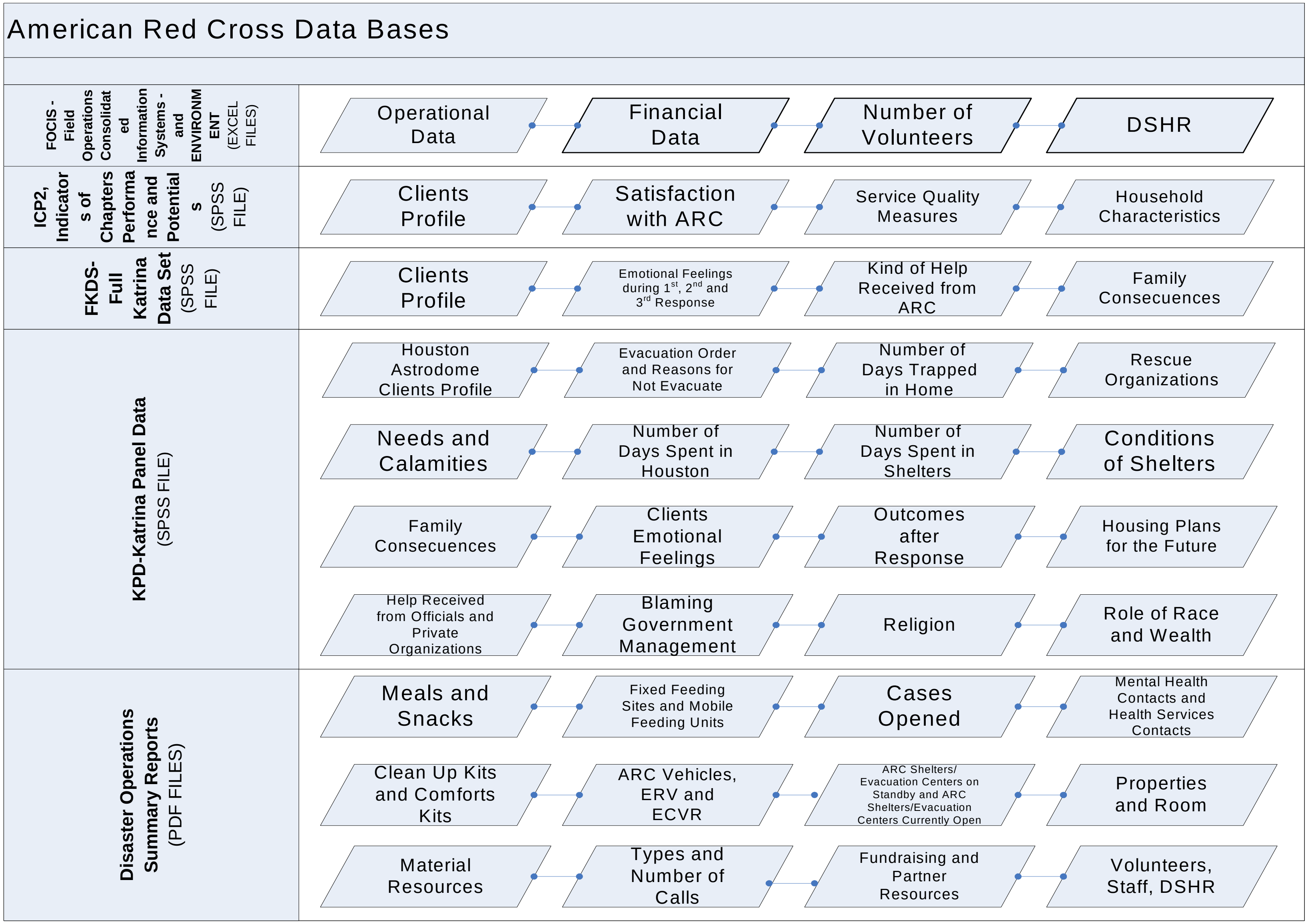


Figure 30. American Red Cross Data. Author's Elaboration, 2008.

3.6 KEY VARIABLES IN THE KATRINA OPERATION ESTIMATED BY "OTHER SOURCES"

A bibliographic search on the number of people affected by Katrina and were in a shelter, revealed the fact that different agencies and authors provide different numbers for the evacuation, and are somewhat different to the Red Cross' results. The results of other authors' (Boyd et al. (2008), FEMA (2007) and CRS (2005)) estimations about the number of people evacuated during Katrina relief operation compared to the simulation results of the SQRC model are shown in Table 9.

Table 9. Comparison Evacuated Population. Author's Elaboration, 2008.

Population	Boyd et al. (2008)	FEMA (2007)	CRS (Congressional Research Services) (2005)
Total Affected Population (LA, MS, AL)	NA	NA	**711,698**
Total Evacuated Population Before	1,000,000	NA	**NA**
Total Evacuated Population After	100,000	NA	**NA**
Total Evacuated Population During	100,000	NA	**NA**
Not Evacuated Population	130,000	NA	**NA**
People in Shelter	67,800	62,000	**NA**
Evacuated Population	780,353	1,040,000	**NA**
Not Sheltered	**NA**	**NA**	**NA**

These authors' evacuated population estimations were made considering the following counties or parishes:

A. Boyd et al. considered the population from Parish: Orleans, Jefferson, St. Bernard and Plaquemines.

B. FEMA considered the population from The Greater New Orleans.

C. CRS considered the following Counties/parishes:

- Alabama (selected counties): Baldwin and Mobile.
- Louisiana (selected parishes): Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. Tammany and Tangipahoa.
- Mississippi (selected counties): Hancock, Harrison and Jackson.

3.7 DATA MINING

Data mining techniques were applied to discover hidden knowledge and unexpected patterns in databases; analyze data from many different perspectives, categorize it, and summarize the identified relationships.

Specifically classification trees (Tree-shaped structures that represent sets of decisions) technique was used to generate rules for the classification of the data set.

The classification trees were generated based in the SPSS databases to predict responses on a categorical dependent variable. The dependent and independent variables were carefully chosen having in mind aspects related with affected community, service quality and reasons for evacuation. The growing method chosen was Exhaustive CHAID.

Once the trees were created, IF-THEN statements were used to explain the likelihood of the selected variables (see appendix D).

3.8 FINDING RELATIONSHIPS AMONG VARIABLES

The relationships were determined among variables, such as, concepts, perceptions and opinions, collected through surveys and deposited in the American Red Cross databases.

3.8.1 Data Analysis with Chi-Squared Automatic Interaction Detector (CHAID)

Chi-squared Automatic Interaction Detector (CHAID) is an efficient statistical technique for segmentation, or tree growing. With CHAID one can construct more than two categories at any particular level in a tree. Other growing methods (e.g. CART) produce a wider tree than do the binary (Kass, 1980).

The following procedure was applied to analyze the American Red Cross databases:

- Separation of the population into two or more groups based on the categories of the “best” predictor of a dependent variable.

- Values that are judged to be statistically homogeneous were joined with respect to the target variable and all other values that are heterogeneous continued.

- Separation of each of these groups into smaller subgroups based on the best available predictor at each level. The splitting process persisted until no more statistically significant predictors can be discovered or until some other stopping rule is met.

- The CHAID software exhibit the final subgroups in the form of a tree diagram whose branches correspond to the groups (Kass, 1980).

A node can not be divided if any of the following conditions were met:

- All cases in a node have identical values for all predictors.

- All cases in the node have the same value of the dependent variable.

- The depth of the tree has achieved its pre-specified maximum value.

- The number of cases composing the node is less than a pre-specified minimum parent node size.

- The split at the node results in producing a child node whose number of cases is less than a pre-specified minimum child node size.

- No more statistically significant split can be found at the specified level of significance (Kass, 1980) (see appendix D).

3.9 GRAPHICAL REPRESENTATIONS

Decision tree graphs were illustrated as part of the data analysis. The extensive results are shown in appendix D but the main findings are summarized here:

- The main predictor of “Evacuate House or Apartment due to Hurricane Katrina” is “Own/Rent House or Apartment”.

- The main predictor of “Spent at Least One Night in an Emergency Shelter” is “Evacuate House or Apartment due to Hurricane Katrina”

- The main predictor of victim satisfaction with the service was found to be “Receive from Red Cross: Financial Assistance”.

3.10 MAPPING SYSTEM STRUCTURE

This section shows how the conceptual model is operationalized by identifying key observed variables. This model can be applied specifically to the American Red Cross relief operation (see Figure 31).

A. Model Boundary Chart: In here the scope of the model it is summarized by listing the model's key variables classified as endogenous, exogenous and excluded (see Table 10).

Table 10. Model Boundary Chart for SQRC Model. Author's Elaboration, 2008.

Endogenous	Exogenous	Excluded
Population Affected	Client's Profile	Partner Services.
Client's Disposition for Evacuation	Demographic Characteristic	Material Support Services.
Evacuated Population	Hurricane Level	Information Management Support Services.
People in Shelter	Client's Profile	Organization Support Services.
Opened Shelters		
Opened Cases		
Served Meals		
Financial Assistance		
Mental Health Care		
Staff Availability		
Staff Capacity		
New Volunteers		
Volunteers Trained		
DSHR (Disaster Services Human Resource) Capacity		
Mass Care Capacity		
Individual Client Services Capacity		
Staff Services Capacity		
Needs Met		
Client's Perceptions ARC Service		
Total Service Quality Perception		
Client's Satisfaction		
Goal for Satisfaction		
Cash Donations		

Resources Available		
Resources Stored		

B. Causal Loop Diagram: It is used to depict the feedback structure of system representation. It contains observed variables connected by arrows indicating the causal influences among the variables. It put emphasis on the feedback structure of a system.

It shows a casual structure map based on initial hypotheses, key variables, reference modes, and other available data (Sterman, 2000).

Next, an explanation is provided of how this causal-loop diagram works:

- Basic "***Demographic Characteristics***" like household income information can be decisive to assess and determine the response of the "***Population Affected***" of a disaster area. It is a critical factor considering the reasons a client has to evacuate a potential disaster site.

- It is a critical factor considering the reasons a client has to evacuate a potential disaster site. Depending on the reasons for evacuation, clients make the decision of abandoning, or not, this potential disaster site. Reasons for evacuation can vary, and embrace different aspects, and it depends on the lifestyle of each of them. Situations like ethnical background and be a realty owner or not, are some of the aspects that influence that kind of decision. Therefore, "***Client's Profile***" influences the "***Population Affected***" and the "***Client's Disposition for Evacuation***".

- Then "***Client's Disposition for Evacuation***" influences the amount of "***Evacuated Population***". In addition, the "***Population Affected***" by the disaster influences the amount of "***Evacuated Population***".

- The quantity of "***Evacuated Population***" establishes the amount of "***People in Shelter***".

- The American Red Cross' Disaster Services Human Resources (DSHR) system facilitates prompt and efficient disaster relief services to the American people, and it is composed by any Red Cross unit employee or volunteer who has the identified competencies to assume the responsibility to carry out an identified activity in support of a disaster response.

- The American Red Cross' Staff carry out activities and services necessary to ensure the ability of Red Cross employees and volunteers, including spontaneous volunteers, to meet the needs of the people and communities affected by the disaster.

- Therefore, recruiting "***New Volunteers***" affects the number of "***Volunteers Trained***". The number of "***Volunteers Trained***" influences the amount of "***DSHR Capacity***". In the same way, "***Staff Availability***" affects "***Staff Capacity***".

- On the other hand, the characterization of the destructive potential of hurricanes impacts the recruiting of volunteers. Therefore, "***Hurricane Level***" influences "***New Volunteers***".

- Mass Care starts once a notification of an impending disaster or immediately following a disaster event arrives and must be initiated offering individual or congregate temporary shelters, fixed or mobile feeding to the affected people. Therefore, "***Opened Shelters***" and "***Served Meals***" influence "***Mass Care Capacity***".

- Individual Client Services starts with the opening of cases through caseworkers. Then, direct financial assistance for replacement of essential items is provided. Therefore, "***Opened Cases***" and "***Financial Assistance***" influence "***Individual Client Services Capacity***".

- To carry out Mass Care and Individual Client Services activities it is necessary to count on the availability of resources provided by the ARC. Then the "***Resources Available***" affects "***Mass Care Capacity***" and "***Individual Client Services Capacity***"***.***

- On the other hand, focusing resources available to accomplish service delivery efficiently for a specific disaster, requires that there be in stock some of the necessary resources that need to be suitably balanced among the many inputs used to respond during the disaster relief operation. Large numbers of volunteers are useless without adequately built, equipped, and supplied facilities. Therefore, "***Resources Stored***" affects "***Resources Available***".

- ARC resources are important to minimize impact on the affected community and could be, or not, adequate for the actions' success. Therefore, "***People in Shelter***" determines the amount of resources needed to be deployed in terms of "***DSHR Capacity***", "***Opened Shelters***", "***Served Meals***", "***Opened Cases***", "***Financial Assistance***" and "***Mental Health Care***"***.***

- The provision of mental health care to the population affected depends on the number of ARC personnel available for this activity.

- Another aspect is the emergency assistance provided to minimize immediate disaster-caused needs through the provision of material items depends on the quantity of resources deployed during mass care activities. This is called hard assistance and includes mass feeding and shelter.

- A case is a one-two page document that describes a disaster, crystallizes the disaster victims' needs, describes the Red Cross response, asks for money, and informs donors and prospects how to donate. The case statement should be developed within the first 24-48 hours of the disaster and should be updated regularly to reflect current and relevant information.

- Direct financial assistance is provided through caseworkers to individual victims.

- Then, "***DSHR Capacity***" affects the "***Served Meals***", "***Opened Cases***", "***Financial Assistance***", and "***Mental Health Care***".

- The amount of personnel to be deployed in order to assist relief operations is also determined for the quantity of resources needs to be allocated. Therefore, "***Opened Cases***", "***Served Meals***", and "***Financial Assistance***", influence "***DSHR Capacity***".

- Material Support Services is a function of the Red Cross that supports activities and services necessary to conduct a disaster relief operation, including the securing of facilities. Therefore, the personnel involved in this function are in charge of identify sources for facilities and make the appropriate arrangements to open these facilities as shelters. This is the reason DSHR is not in function of "Opened Shelters", because this function of the ARC is not included in this model.

- Finally, the amount of personnel and material resources deployed to the disaster site in order to assist victims immediate needs establish whether these needs were met or not. Therefore, "***Mass Care Capacity***", "***Individual Client Services Capacity***" and "***Staff Services Capacity***" influence "***Needs Met***".

- If needs are met or not changes clients' perceptions of the service received. Then, "***Needs Met***" influences "***Client's Perception ARC Service***". Clients' perceptions of the service are the beginning point of the evaluation of the service received overall. Then "***Client's Perception ARC Service***" influences "***Total Service Quality Perception***".

- Therefore, "***Total Service Quality Perception***" influences "***Client's Satisfaction***".

- When a service is not performed according to the standards, this creates a performance gap. This performance gap depends on satisfaction and perceptions of the total service quality provided.

- "***Goal for Satisfaction***" of this system consists in reducing the Performance Gap to zero. However, there is a delay in the reaction of the Red Cross organization to reports of client dissatisfaction. The correction is not immediate. Then, "***Goal for Satisfaction***" influences "***Client's Satisfaction***".

- People's views about humanitarian services are only partly formed by their direct use of those services. The role of the Media is highly influenced by the people's overall views of the performance of an organization, such as, the American Red Cross. This means that the "***Client's Satisfaction***" of the service received affects the role of the "***Media***".

- Therefore, "***Media***" and points of view of the "***People in Shelte*r**" are important factors in the process of "***Public Opinion***" formation, it can influence community opinions, and those controlling the media are capable of changing the nature of discourse in their desired direction.

- "***Public Opinion***" also affects the recruiting of "***New Volunteers***".

- It is in this way, that "***Public Opinion***" becomes an imperative mobilizing weapon when an outage strike due to the right of people to be concern about the destination of "***Cash Donations***" that they make to these kinds of events. As a result, the positive or negative influence of "***Public Opinion***" affects "***Donations***" cash flows made by community.

- These cash flows made by the non-affected communities determines the amount of resources the relief organization can obtain to assist people in the disaster site. Then, "***Cash Donations***" affects "***Resources Available***".

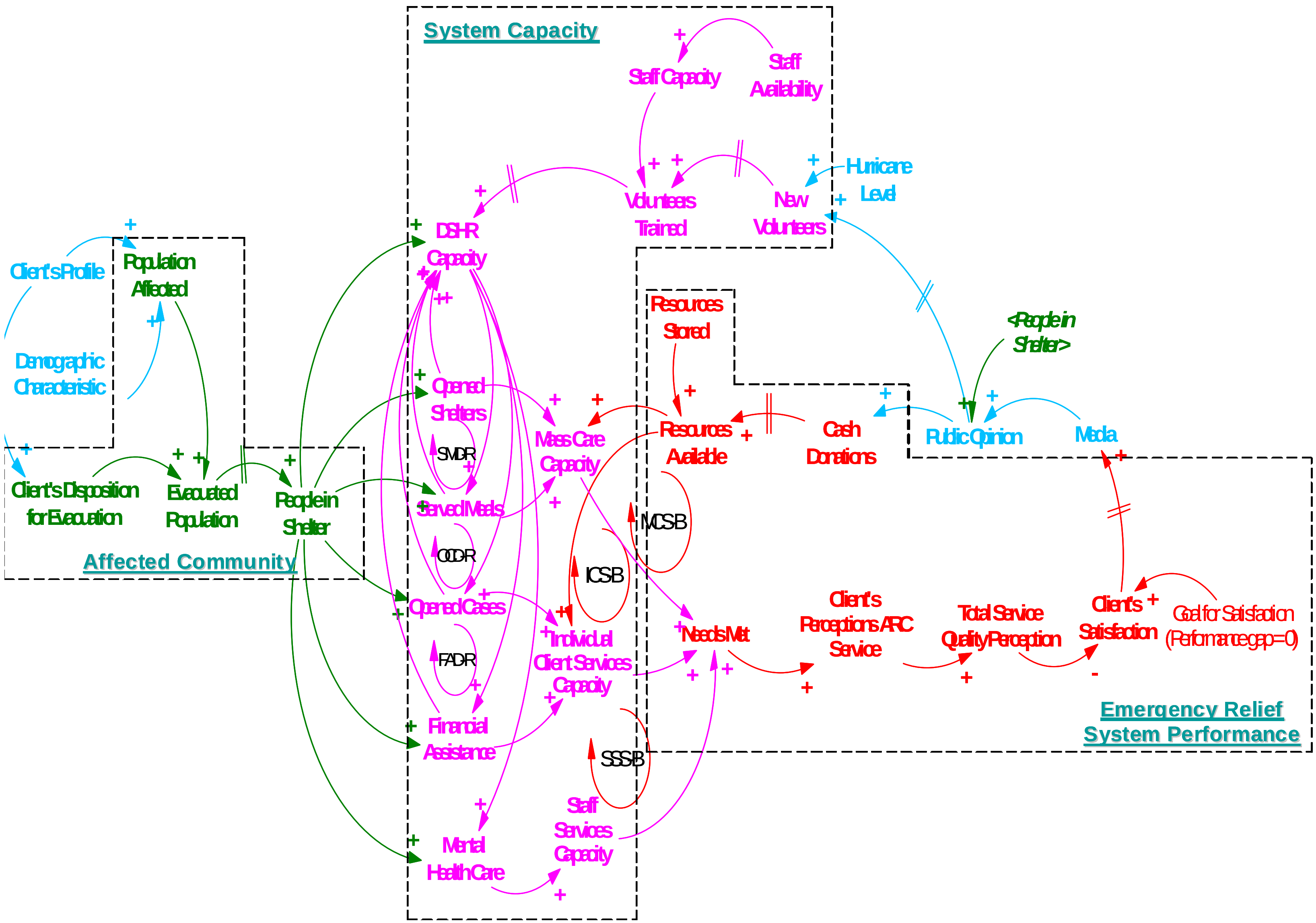


Figure 31. Causal-Loop Diagram. Author's Elaboration, 2008.

<u>Description of the Service Quality Response Cycle (SQRC) Causal Loop Diagram</u>

The overall causal loop diagram of the system is shown in Figure 31.

Now, taking reference to the polarities of this causal-loop diagram the above figure shows a possible set of causal relationships within this model. The arrows indicate the causal direction of influences. The signs beside the arrows indicate the polarity. A plus (+) sign implies that a change in the variable at the end of the arrow will cause a change in the variable at the top of the arrow in the same direction. Likewise, a minus (-) sign means that a change in the variable at the end of the arrow will cause a change in the variable at the top of the arrow in the opposite direction.

The various feedback loops manifested in the causal loop diagram are described in detail as follows.

<u>"Mass Care Capacity" - Satisfaction Loop (MCS-B)</u>

The arrow from "***Client's Perceptions ARC Service***" to "***Total Service Quality Perception***" is cited as a positive influence: An *increase* (*decrease*) in the "Client's Perception ARC Service" *increases* (*decreases*) "Total Service Quality Perception". The arrow from "***Total Service Quality Perception***" to "***Client's Satisfaction***" is given as a negative influence: An *increase* (*decrease*) in "Total Service Quality Perception" will cause a *decrease* (increase) in the "Client's Satisfaction". The arrow from "***Client's Satisfaction***" to "***Media***" is cited as a positive influence: An *increase* (*decrease*) in the "Client's Satisfaction" *increases* (*decreases*) "Media". The arrow from "***Media***" to "***Public Opinion***" is given as a positive influence: An *increase* (*decrease*) in the "Media" will cause an *increase* (*decrease*) in the "Public Opinion". The arrow from "***Public Opinion***" to "***Cash Donation***" is cited as a positive influence: An *increase* (*decrease*) in the "Public Opinion" *increases* (*decreases*) "Cash Donation". The arrow from "***Cash Donation***" to "***Resources Available***" is given as a positive influence: An *increase* (*decrease*) in the "Cash Donation" will cause an *increase* (*decrease*) in the "Resources Available". The arrow from "***Resources Available***" to "***Mass Care Capacity***" is cited as a positive influence: An *increase* (*decrease*) in the "Resources Available" *increases* (*decreases*) "Mass Care Capacity". The arrow from "***Mass Care Capacity***" to "***Needs Met***" is given as a positive influence: An *increase* (*decrease*) in the "Mass Care Capacity" will cause an *increase* (*decrease*) in the "Needs Met". The arrow from "***Needs Met***" to "***Client's Perceptions ARC Service***" is given as a positive influence: An *increase* (*decrease*) in the "Needs Met" will cause an *increase* (*decrease*) in the "Client's Perceptions ARC Service".

Therefore, this feedback structure corresponds to a negative exponential **Goal Seeking** behavior. The loop is a negative feedback loop which is expressed as a balancing behavior, and it is labeled as MCS-B (see Figure 32).

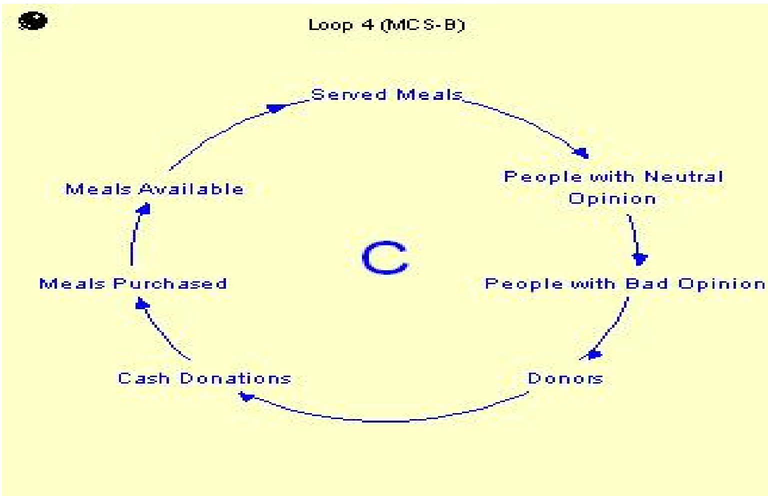


Figure 32. MCS-B Loop. Author's Elaboration, 2008.

Negative loops seek balance equilibrium, and stasis. Negative feedback loops act to bring the state of the system in line with the goal of the desired state. They counteract any disturbances that move the state of the system away from the goal (Sterman, 2000). The goal seeking behavior follows the structure shown in Figure 33:

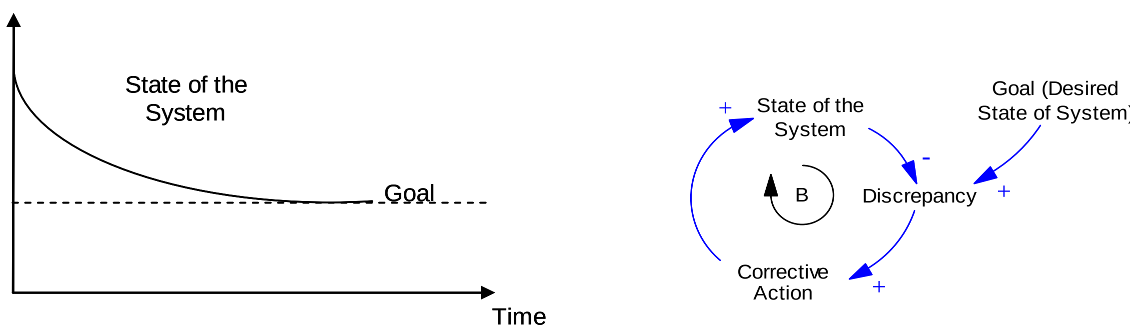


Figure 33. Exponential Decay Structure and Behavior. Sterman, 2000.

To reach the Desired State (Performance gap equals to zero) it is necessary the balancing of three performance dimensions: service quality, effectiveness (client's change in perceptions, knowledge and behavioral intentions) and efficiency (weight combinations of resources and services). Therefore, the State "**Total Service Quality Perception**" seeks the "**Goal for Satisfaction**" (Desired State), via "**Client's Perceptions ARC Service**".

<u>“Individual Client Services Capacity” - Satisfaction Loop (ICS-B)</u>

The arrow from “***Client’s Perceptions ARC Service***” to “***Total Service Quality Perception***” is cited as a positive influence: An *increase* (*decrease*) in the “Client’s Perception ARC Service” *increases* (*decreases*) “Total Service Quality Perception”. The arrow from “***Total Service Quality Perception***” to “***Client’s Satisfaction***” is given as a negative influence: An *increase* (*decrease*) in “Total Service Quality Perception” will cause a *decrease* (increase) in the “Client’s Satisfaction”. The arrow from “***Client’s Satisfaction***” to “***Media***” is cited as a positive influence: An *increase* (*decrease*) in the “Client’s Satisfaction” *increases* (*decreases*) “Media”. The arrow from “***Media***” to “***Public Opinion***” is given as a positive influence: An *increase* (*decrease*) in the “Media” will cause an *increase* (*decrease*) in the “Public Opinion”. The arrow from “***Public Opinion***” to “***Cash Donation***” is cited as a positive influence: An *increase* (*decrease*) in the “Public Opinion” *increases* (*decreases*) “Cash Donation”. The arrow from “***Cash Donation***” to “***Resources Available***” is given as a positive influence: An *increase* (*decrease*) in the “Cash Donation” will cause an *increase* (*decrease*) in the “Resources Available”. The arrow from “***Resources Available***” to “***Individual Client Services Capacity***” is cited as a positive influence: An *increase* (*decrease*) in the “Resources Available” *increases* (*decreases*) “Individual Client Services Capacity”. The arrow from “***Individual Client Services Capacity***” to “***Needs Met***” is given as a positive influence: An *increase* (*decrease*) in the “Individual Client Services Capacity” will cause an *increase* (*decrease*) in the “Needs Met”. The arrow from “***Needs Met***” to “***Client’s Perceptions ARC Service***” is given as a positive influence: An *increase* (*decrease*) in the “Needs Met” will cause an *increase* (*decrease*) in the “Client’s Perceptions ARC Service”.

Therefore, this feedback structure corresponds to a negative exponential **Goal Seeking** behavior. The loop is a negative feedback loop which is expressed as a balancing behavior, and it is labeled as ICS-B (see Figure 34 and Figure 33).

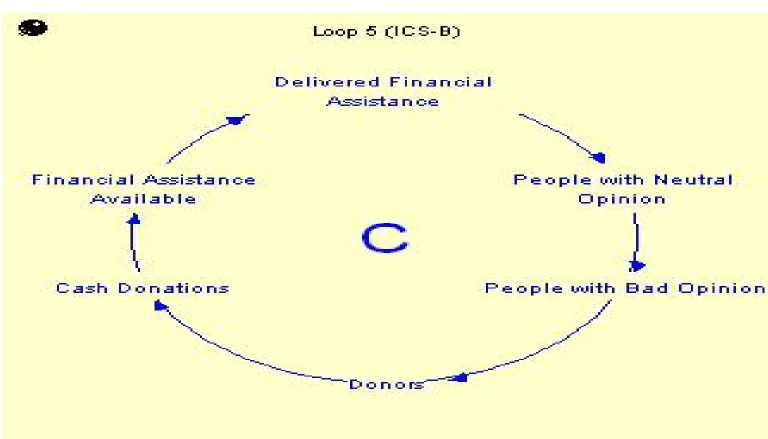


Figure 34. ICS-Loop. Author’s Elaboration, 2008.

<u>“Staff Services Capacity” - Satisfaction Loop (SSS-B)</u>

The arrow from “***Client’s Perceptions ARC Service***” to “***Total Service Quality Perception***” is cited as a positive influence: An *increase* (*decrease*) in the “Client’s Perception ARC Service” *increases* (*decreases*) “Total Service Quality Perception”. The arrow from “***Total Service Quality Perception***” to “***Client’s Satisfaction***” is given as a negative influence: An *increase* (*decrease*) in “Total Service Quality Perception” will cause a *decrease* (increase) in the “Client’s Satisfaction”. The arrow from “***Client’s Satisfaction***” to “***Media***” is cited as a positive influence: An *increase* (*decrease*) in the “Client’s Satisfaction” *increases* (*decreases*) “Media”. The arrow from “***Media***” to “***Public Opinion***” is given as a positive influence: An *increase* (*decrease*) in the “Media” will cause an *increase* (*decrease*) in the “Public Opinion”. The arrow from “***Public Opinion***” to “***New Volunteers***” is cited as a positive influence: An *increase* (*decrease*) in the “Public Opinion” *increases* (*decreases*) “New Volunteers”. The arrow from “***New Volunteers***” to “***Volunteers Trained***” is given as a positive influence: An *increase* (*decrease*) in the “New Volunteers” will cause an *increase* (*decrease*) in “Volunteers Trained”. The arrow from “***Volunteers Trained***” to “***DSHR Capacity***” is cited as a positive influence: An *increase* (*decrease*) in the “Volunteers Trained” *increases* (*decreases*) “DSHR Capacity”. The arrow from “***DSHR Capacity***” to “***Mental Health Care***” is given as a positive influence: An *increase* (*decrease*) in the “DSHR Capacity” will cause an *increase* (*decrease*) in “Mental Health Care”. The arrow from “***Mental Health Care***” to “***Staff Services Capacity***” is cited as a positive influence: An *increase* (*decrease*) in “Mental Health Care” *increases* (*decreases*) “Staff Services Capacity”. The arrow from “***Staff Services Capacity***” to “***Needs Met***” is given as a positive influence: An *increase* (*decrease*) in the “Staff Services Capacity” will cause an *increase* (*decrease*) in the “Needs Met”. The arrow from “***Needs Met***” to “***Client’s Perceptions ARC Service***” is given as a positive influence: An *increase* (*decrease*) in the “Needs Met” will cause an *increase* (*decrease*) in the “Client’s Perceptions ARC Service”.

Therefore, this feedback structure corresponds to a negative exponential **Goal Seeking** behavior. The loop is a negative feedback loop which is expressed as a balancing behavior, and it is labeled as SSS-B (see Figure 35 and Figure 33).

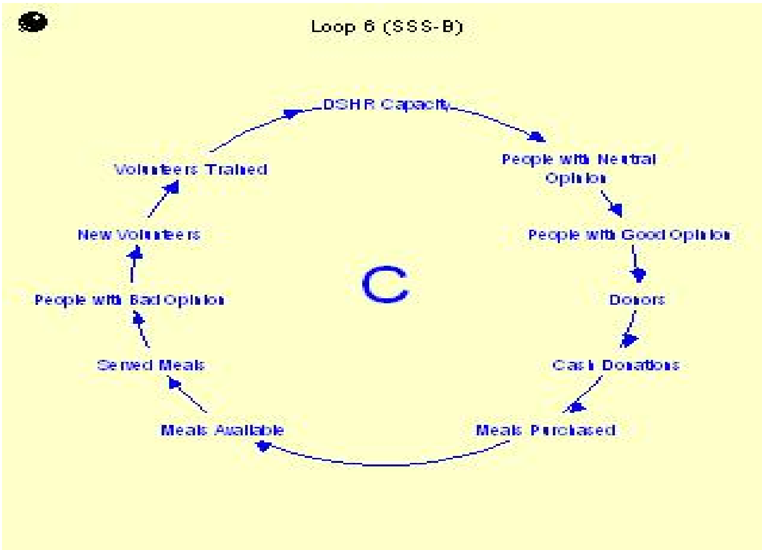


Figure 35. SSS-B Loop. Author's Elaboration, 2008.

<u>"Served Meals" - DSHR Loop (SMD-R)</u>

The arrow from "***Served Meals***" to "***DSHR Capacity***" is cited as a positive influence: An *increase* (*decrease*) in the "Served Meals" *increases* (*decreases*) "DSHR Capacity". The arrow from "***DSHR Capacity***" to "***Served Meals***" is given as a positive influence: An *increase* (*decrease*) in the "DSHR Capacity" *increases* (*decreases*) the "Served Meals".

Therefore, this feedback structure corresponds to an **Exponential Growth** behavior. The loop is a positive feedback loop which is expressed as a reinforcing behavior, and it is named as SMD-R (see Figure 36).

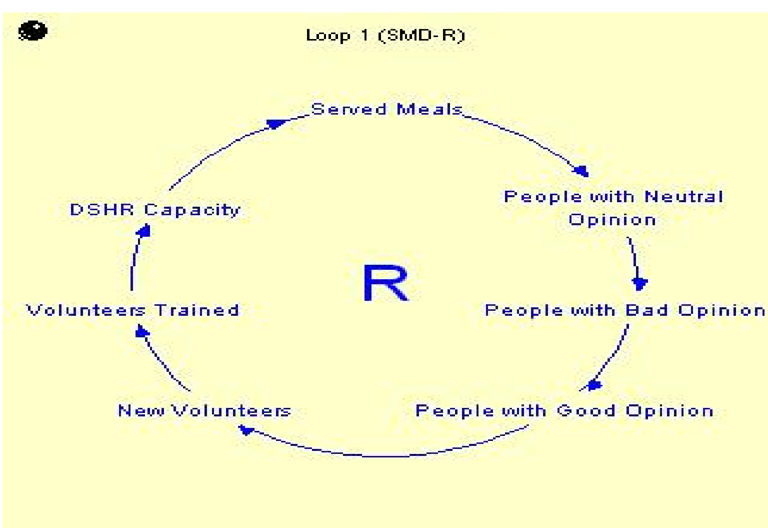


Figure 36. SMD-R Loop. Author's Elaboration, 2008.

State of the System determines Net Increase Rate, and Net Increase Rate adds to State of the System (Sterman, 2000). The exponential growth behavior follows the structure shown in Figure 37.

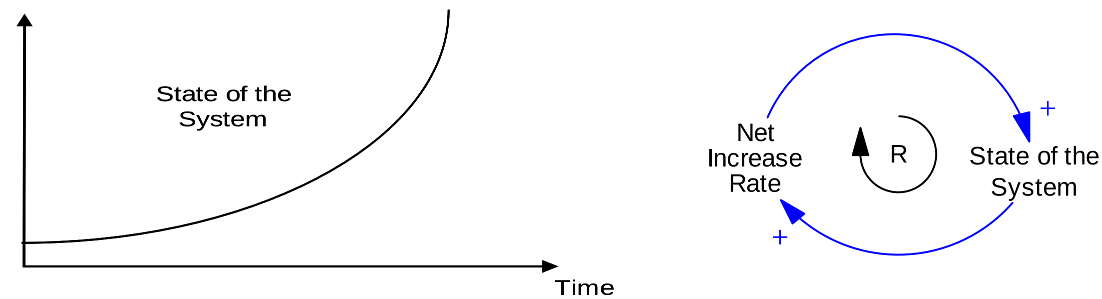


Figure 37. Exponential Growth Structure and Behavior. Sterman, 2000.

<u>"Opened Cases" - DSHR Loop (OCD-R)</u>

The arrow from "***Opened Cases***" to "***DSHR Capacity***" is cited as a positive influence: An *increase* (*decrease*) in the "Opened Cases" *increases* (*decreases*) "DSHR Capacity". The arrow from "***DSHR Capacity***" to "***Opened Cases***" is given as a positive influence: An *increase* (*decrease*) in the "DSHR Capacity" *increases* (*decreases*) the "Opened Cases".

Therefore, this feedback structure corresponds to an **Exponential Growth** behavior. The loop is a positive feedback loop which is expressed as a reinforcing behavior, and it is named as OCD-R (see Figure 38 and Figure 37).

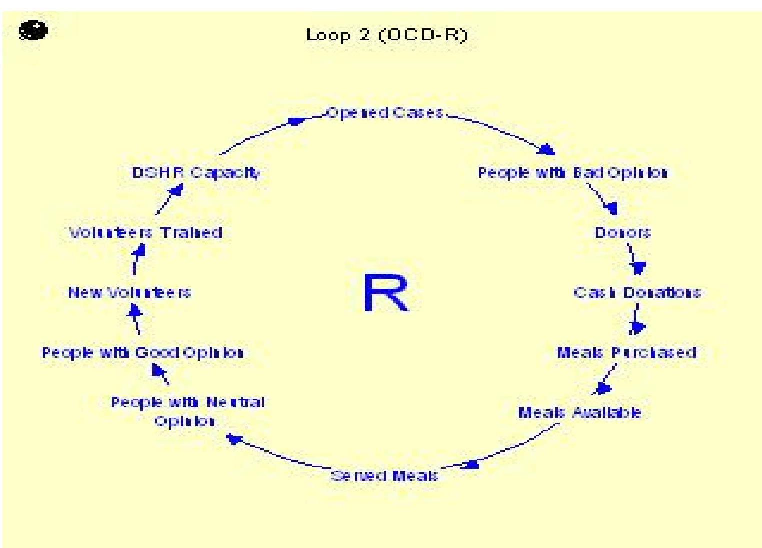


Figure 38. OCD-R Loop. Author's Elaboration, 2008.

<u>"Financial Assistance" - DSHR Loop (FAD-R)</u>

The arrow from "***Financial Assistance***" to "***DSHR Capacity***" is cited as a positive influence: An *increase* (*decrease*) in the "Financial Assistance" *increases* (*decreases*) "DSHR Capacity". The arrow from "***DSHR Capacity***" to "***Financial Assistance***" is given as a positive influence: An *increase* (*decrease*) in the "DSHR Capacity" *increases* (*decreases*) the "Financial Assistance".

Therefore, this feedback structure corresponds to an **Exponential Growth** behavior. The loop is a positive feedback loop which is expressed as a reinforcing behavior, and it is named as FAD-R (see Figure 39 and Figure 37).

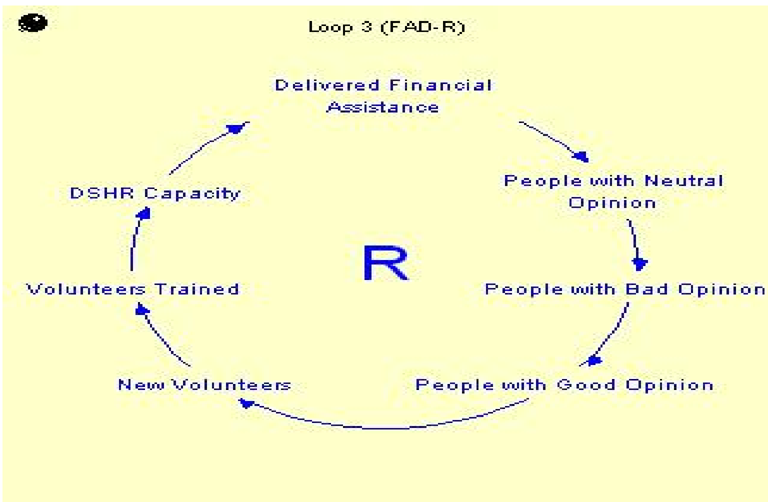


Figure 39. FAD-R Loop. Author's Elaboration, 2008.

3.10.1 Formulation of a Simulation Model

In this phase the system description is transformed into a model with equations, parameters and initial conditions that were represented as a stock and flow structure. Following are the steps embraced in the development of this model.

3.10.1.1 Stock and Flow Diagram Notation

The Service Quality Response Cycle stock and flow diagram is represented by Figure 40. The stock and flow structure has a one-to-one correspondence to the causal loop structure presented before, and was built using Stella™.

External Factors

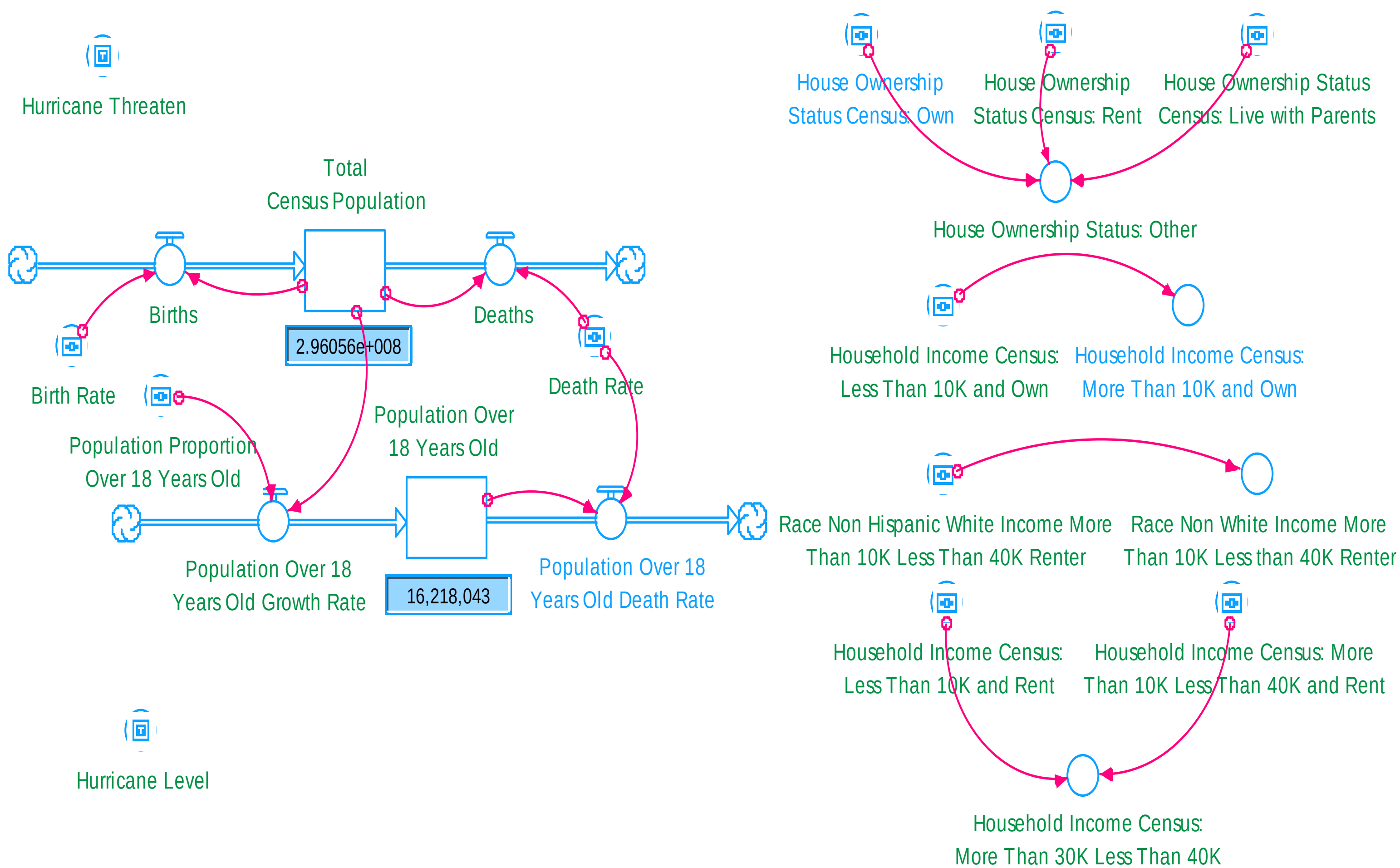


Figure 40. SQRC Stock and Flow Diagram Notation. Author’s Elaboration, 2008.

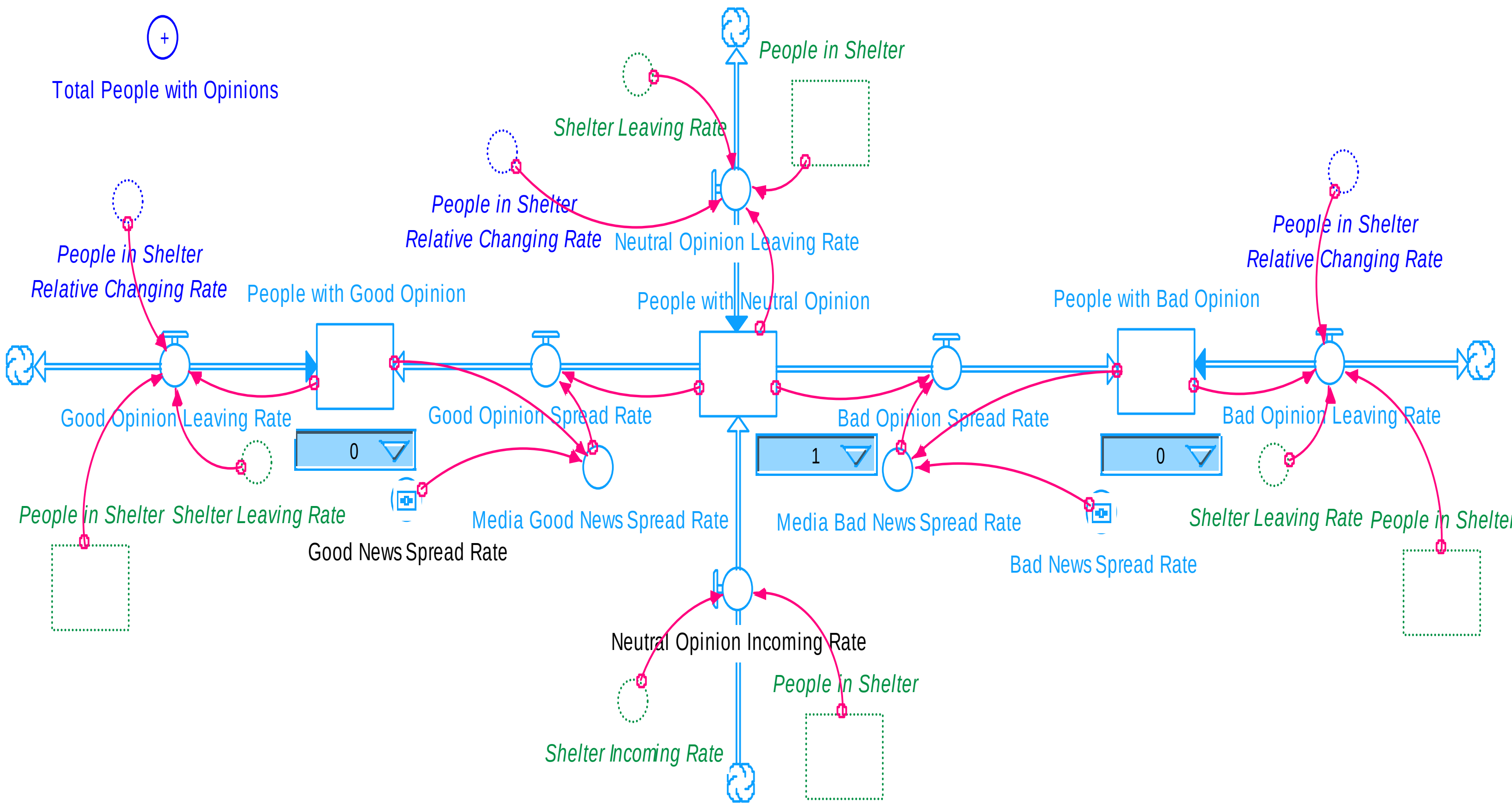


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

Affected Community Subsystem

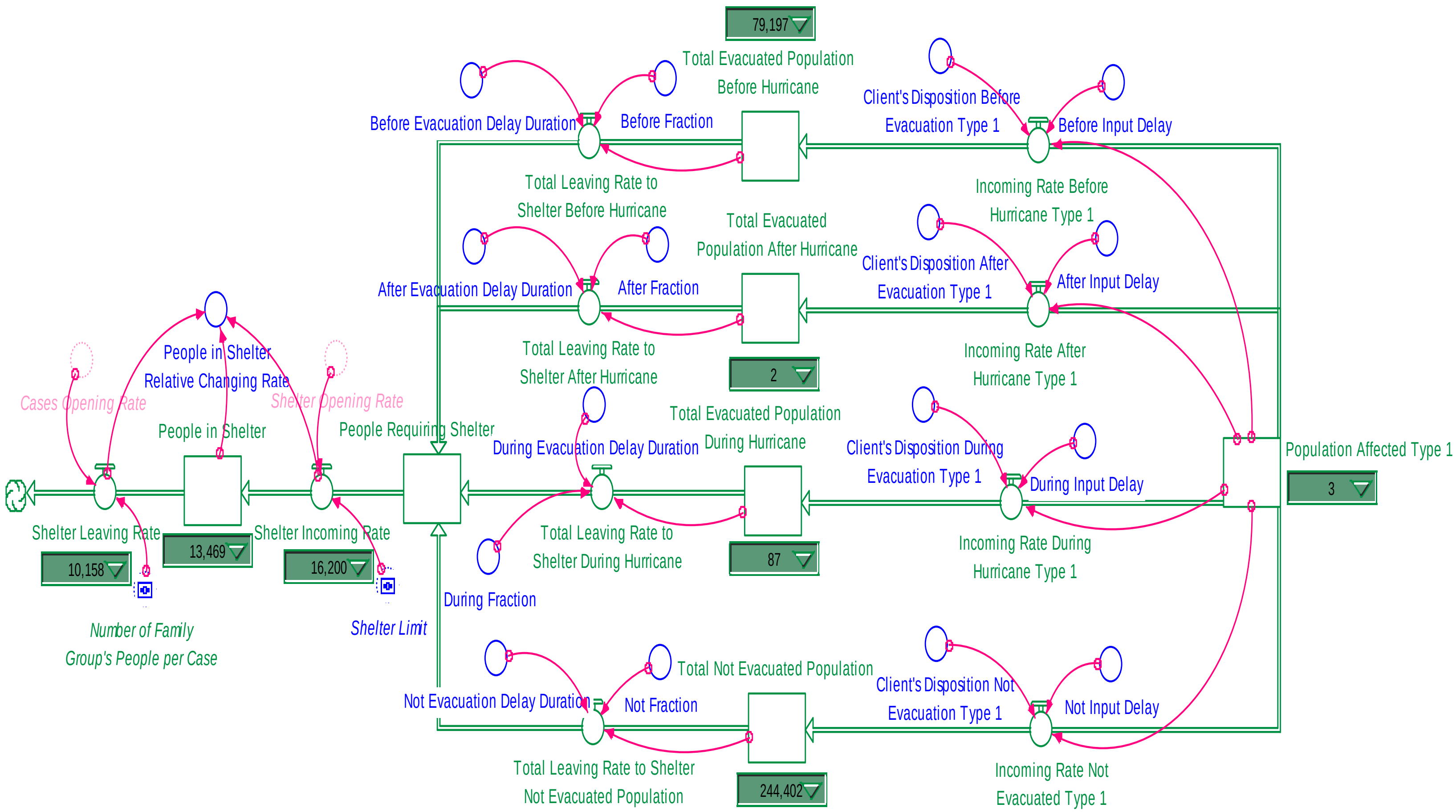


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

This is a schematic representation of one of the eight types of population impacted by the disaster that are included in the affected community subsystem. These types of population mixes were classified depending on demographics characteristics and profile obtained with CHAID analysis.

System Capacity

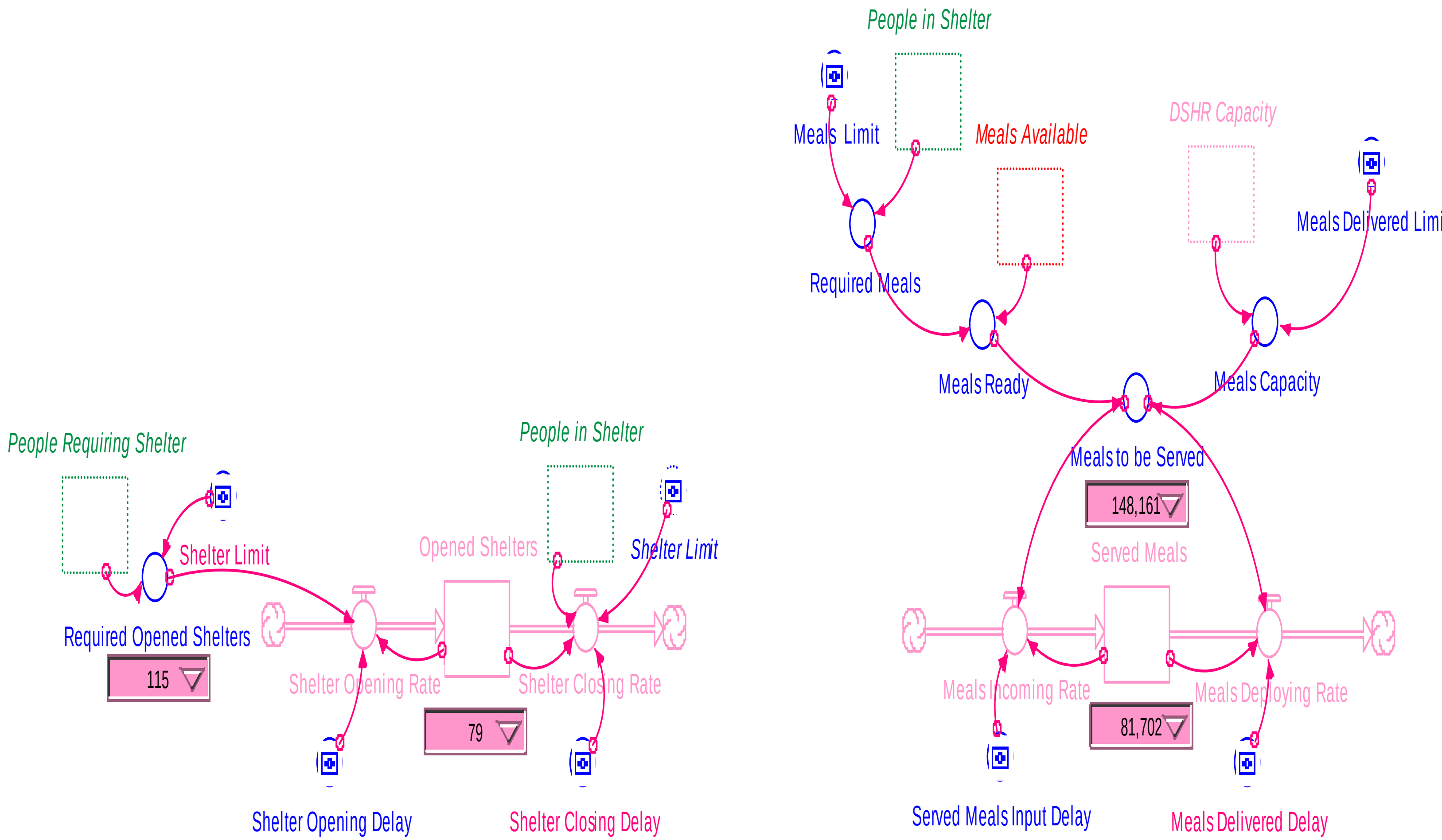


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

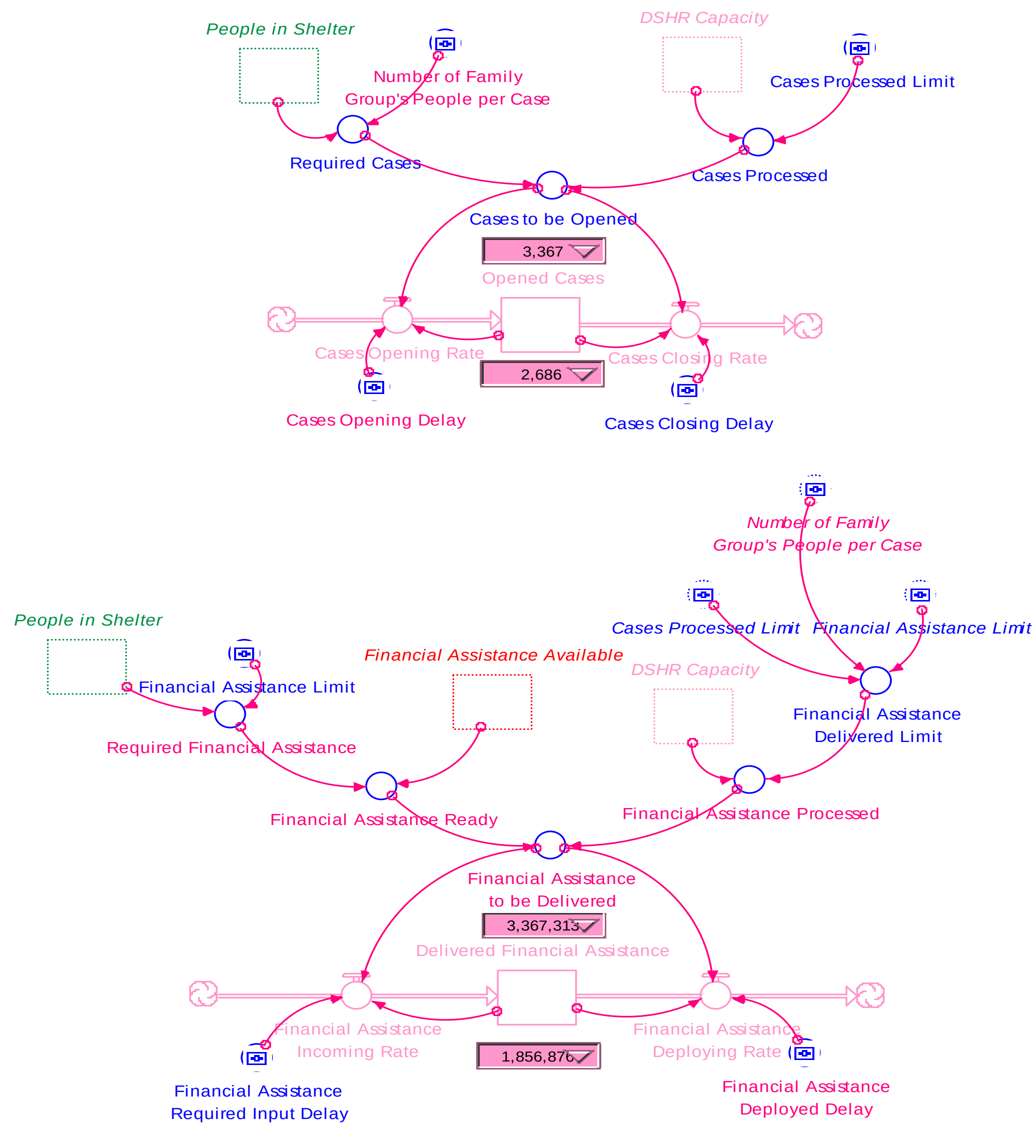


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

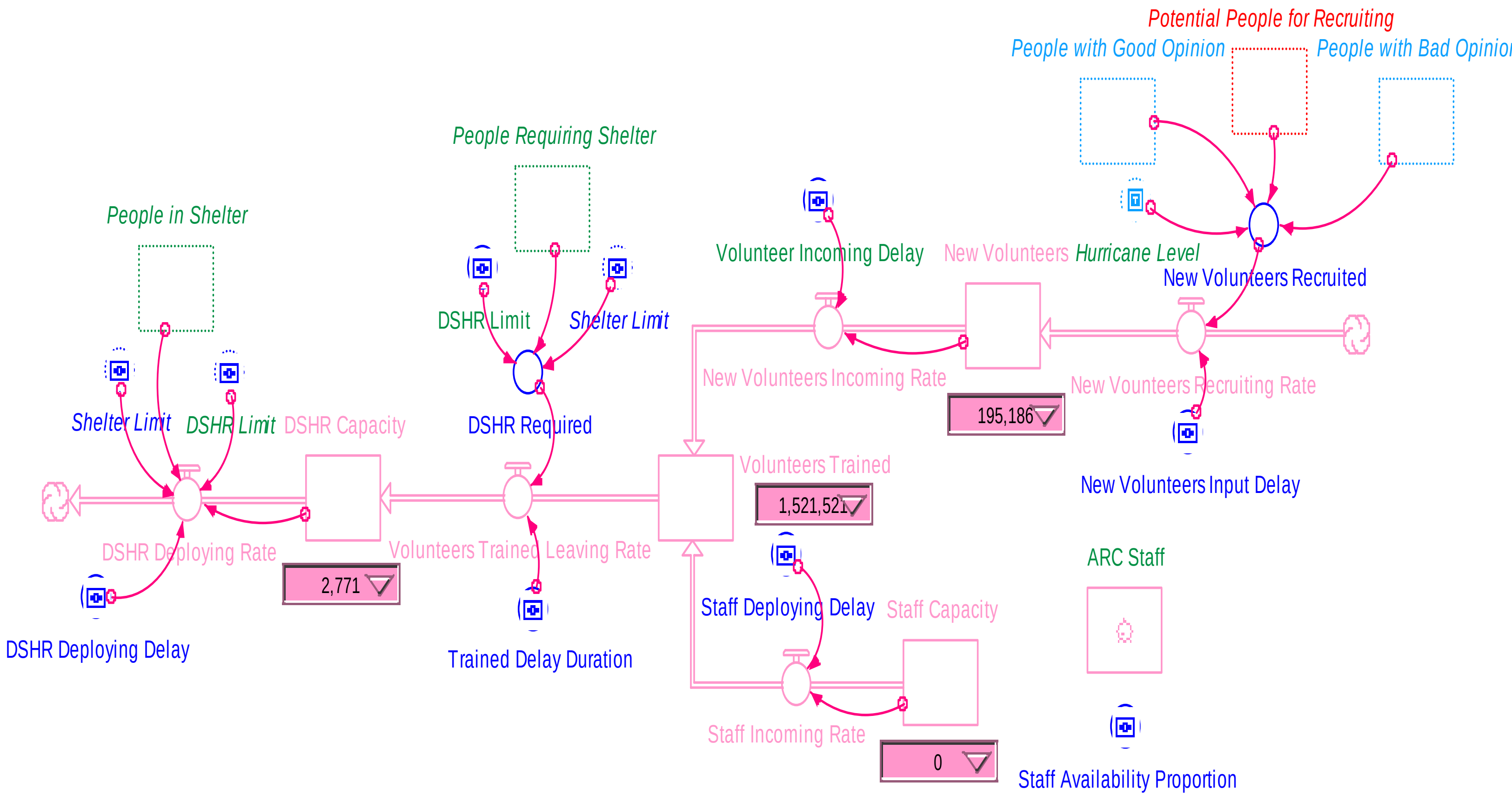


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

Emergency Relief System Performance

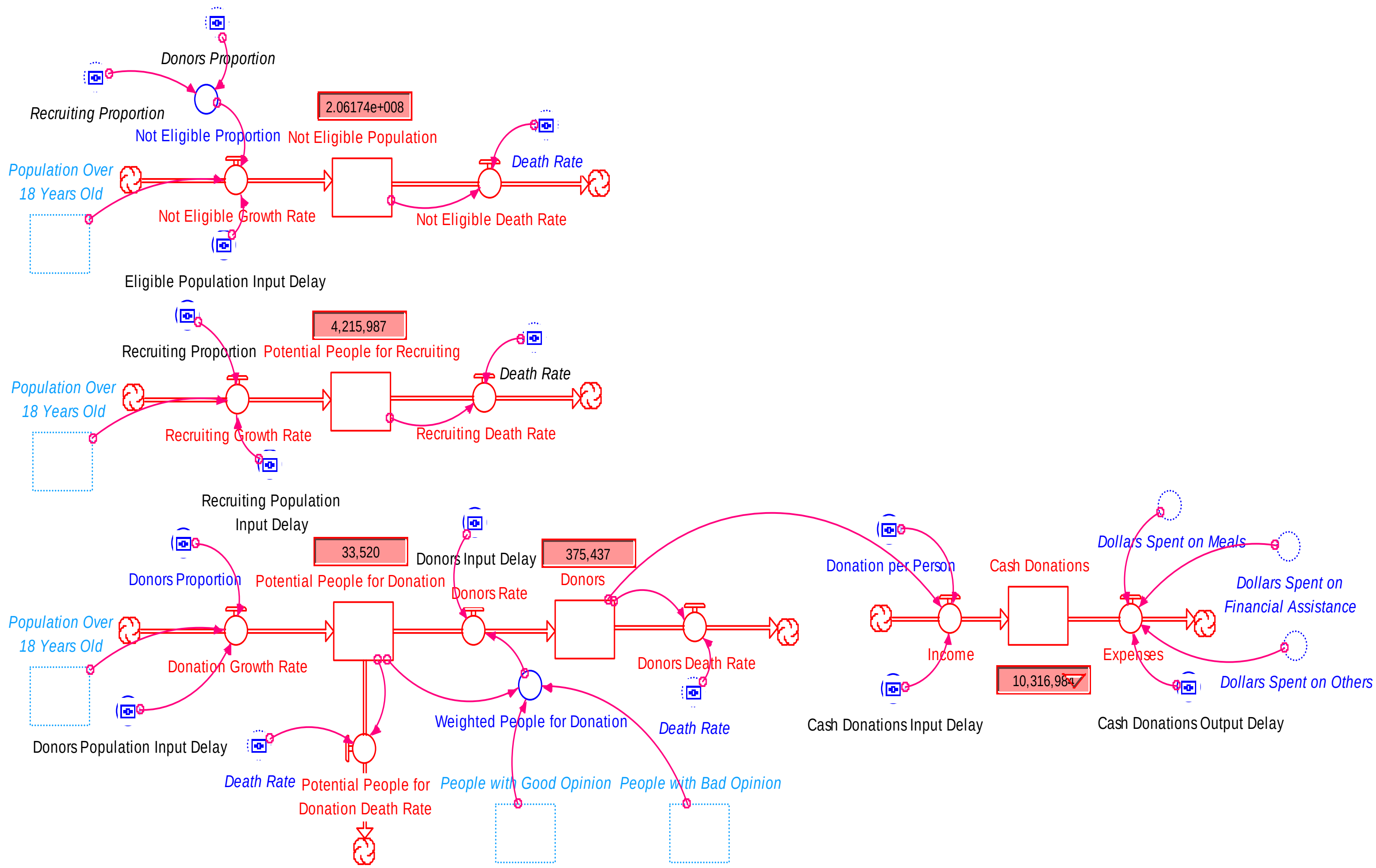


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

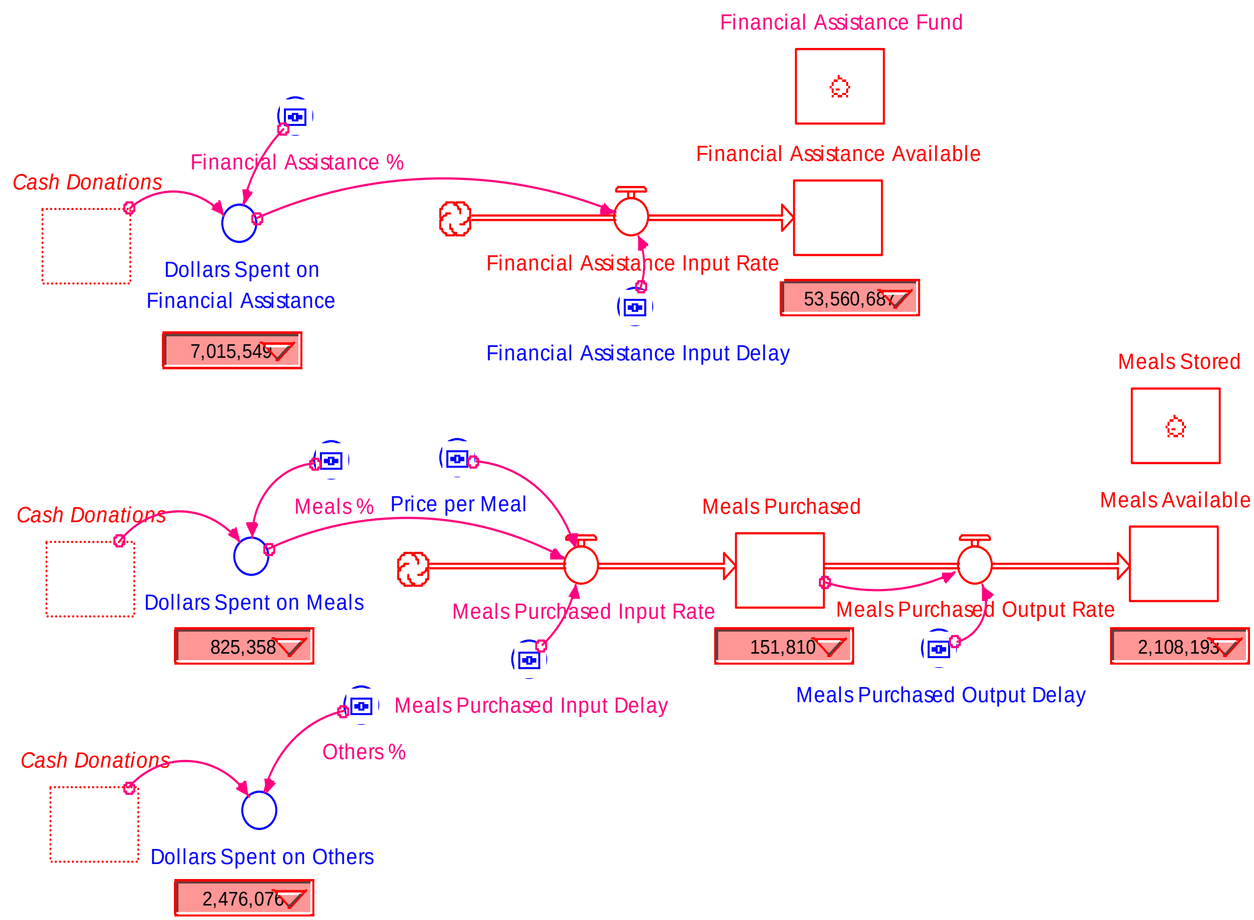


Figure 40. SQRC Stock and Flow Diagram Notation. Author's Elaboration, 2008 (Continued).

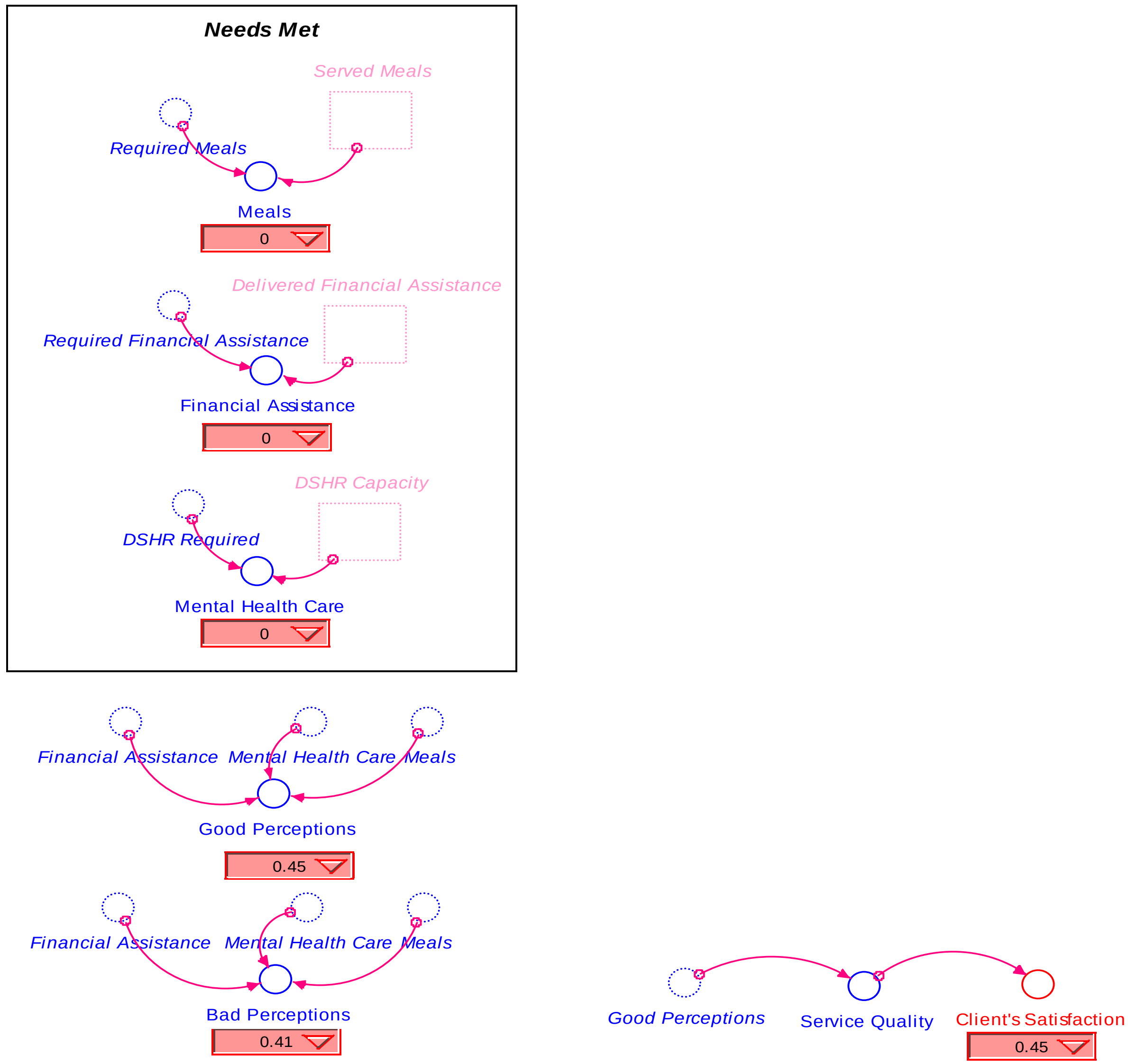


Figure 40. SQRC Stock and Flow Diagram Notation. Author’s Elaboration, 2008 (Continued).

The dominant subsystem of this model is the System Capacity. This subsystem dominates the Emergency Relief System Performance and influences the Affected Community Subsystem.

3.10.1.1.1 Affected Community Subsystem Stock and Flow Structure

In this phase, stock and flow structures of the model were built in order to simulate it. The first step is breaking down the emergency relief into a submodel that describes the characteristics and behaviors of the population impacted by the hurricane path.

- The simulation begins with the establishment of the quantity of people affected for the hurricane by the user's model. "***Total Population Affected***" was defined as a knob input device and provides the initial values for this stock. It remains fixed throughout the simulation (see Figure 41).

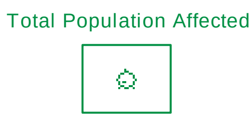


Figure 41. Total Population Affected Knob. Author's Elaboration, 2008.

- Through an analysis of the Red Cross Databases and using SPSS AnswerTree™ for finding relationships among variables it was possible determine the characteristics and behaviors of the population impacted by the hurricane as described in section 3.5 (see Figure 42). Therefore, eight types of population' attributes were defined and were expressed as stocks in the subsystem.

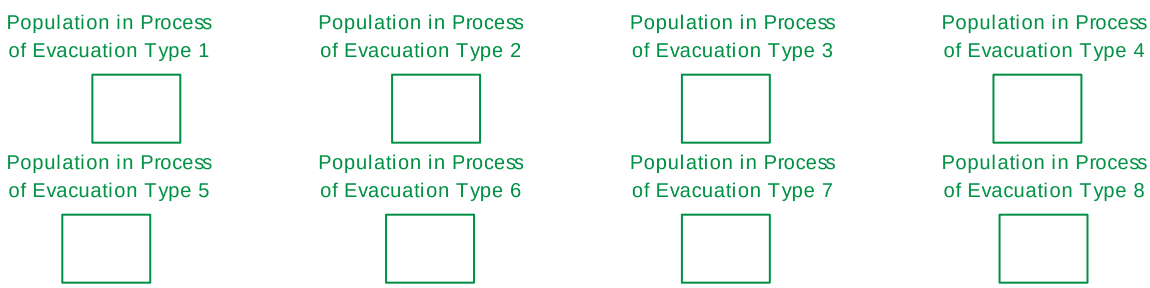


Figure 42. Population Affected Types Stocks. Author's Elaboration, 2008.

Inside each one of them are the variables that classify each type of population depending of the client's household income, race, and whether these clients own/rent a property or not (see appendix F for Equation Definition).

- As explained before, once this population is classified by its demographics characteristics and profile, the process begins by dividing this population into groups depending on when the evacuation occurs (see Figure 43). SPSS Answer Tree™ analysis provided the likelihood of the client's disposition for evacuation before, after, during the hurricane, also for those who did not evacuate (see Figure D-1).

- In the stock and flow diagram, the process of determining when a person evacuated is represented as four outflows that depart from the stocks of population affected types: Incoming Rate Before Hurricane, Incoming Rate After Hurricane, Incoming Rate During Hurricane and Incoming Rate Not Evacuated.

- These outflows define the income to the stocks of: "***Total Evacuated Population Before Hurricane***", "***Total Evacuated Population After Hurricane***", "***Total Evacuated Population During Hurricane***" and "***Total Not Evacuated Population***". These stocks indicate the amount of people that would evacuate in different moments of time of the hurricane event or would not evacuate (see Figure 43).

- Despite the fact that there are people that would evacuate at different moments during the event, not all of them decide to go to a shelter. Using the results from the CHAID analysis it was determined that the people who go to a shelter during each stage of the disaster event constitutes the amount of "***People Requiring Shelter***" (see Figure 43).

- Then, "***Shelter Incoming Rate***" depends on the quantity of shelters ARC can open, "***Shelter Opening Rate***", and the amount of people each shelter can lodge, "***Shelter Limit***". This flow controls the arriving of people to shelters.

- "***People in Shelter***" is defined as a stock accumulates, where the amount people flow into it, and a net amount of people flow out of it.

- Then, "***Shelter Leaving Rate***" depends on the quantity of cases ARC can open, "***Cases Opening Rate***", and the amount of people who compose a case, "***Number of Family Group's People per Case***". This flow controls the departure of people from the shelters (see Figure 44). See appendix F for Equation Definition.

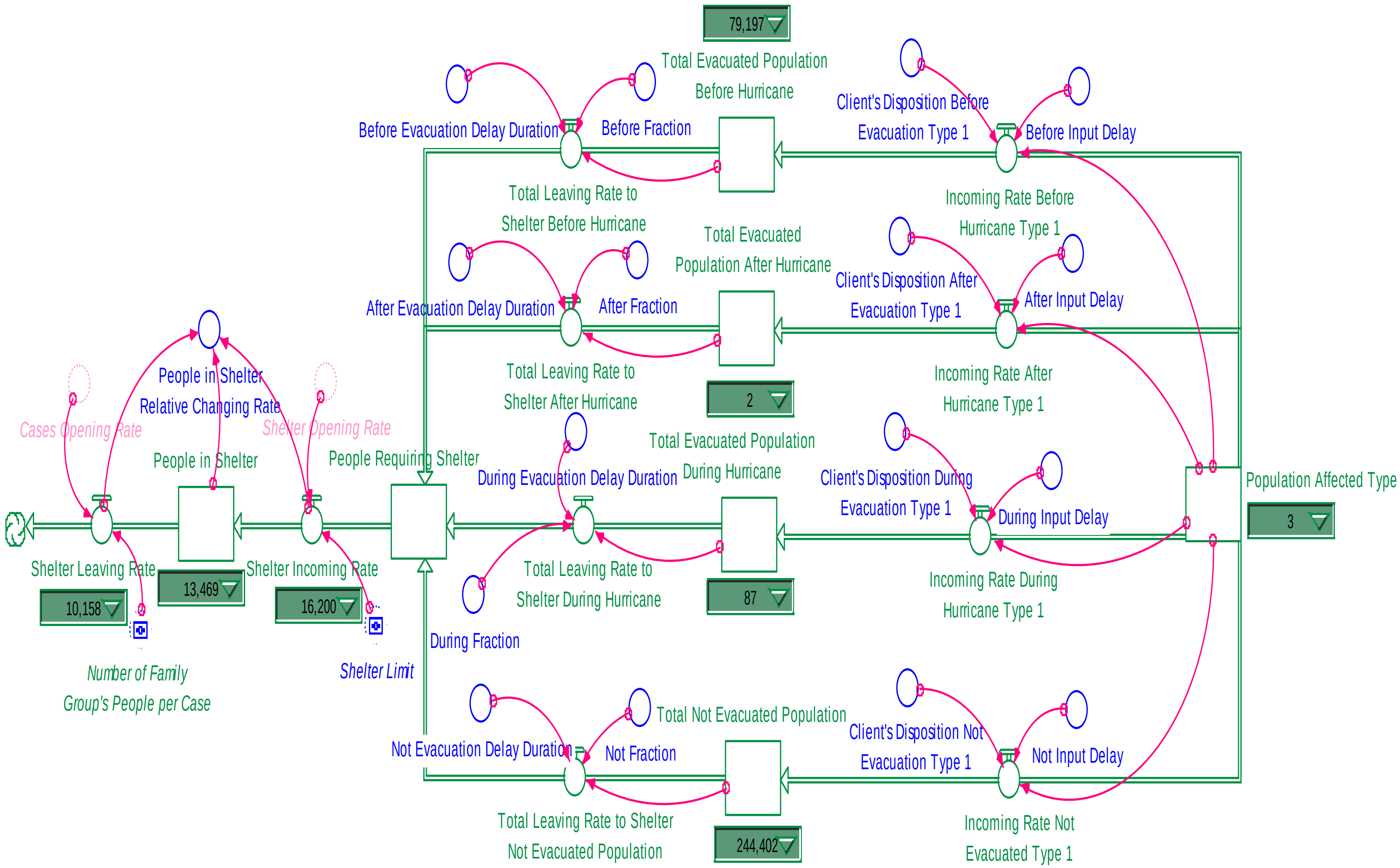


Figure 43. Moment of the Evacuation Stock and Flow Structure. Author's Elaboration, 2008.

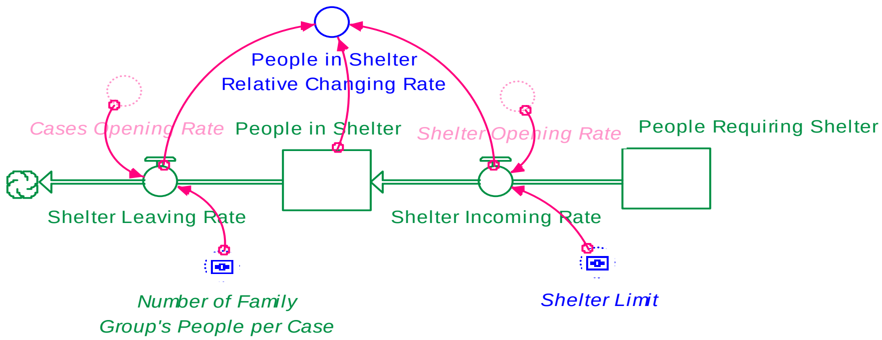


Figure 44. People in Shelter Stock and Flow Structure. Author's Elaboration, 2008.

3.10.1.1.2 System Capacity Stock and Flow Structure

In this sector frame of the model there are stocks, flows and converters specified that model the opening of shelters, cases, the deploying of meals and financial assistance, and the amount of human resources that the American Red Cross needs to deploy in order to meet the people's needs.

- Depending on the "***People Requiring Shelter***" and the "***Shelter Limit***", "***Required Opened Shelters***" are estimated.

- Then, "***Shelter Opening Rate***" depends on the "***Required Opened Shelters***". This flow controls the speed of shelters opening.

- "***Opened Shelters***" is defined as a stock accumulates where the amount of shelters flow into it, and a net amount of shelters flow out of it.

- Therefore, "***Shelter Closing Rate***" depends on the "***People in Shelter***" and the "***Shelter Limit***". This flow controls the closing of shelters (see Figure 45). See appendix F for Equation Definition.

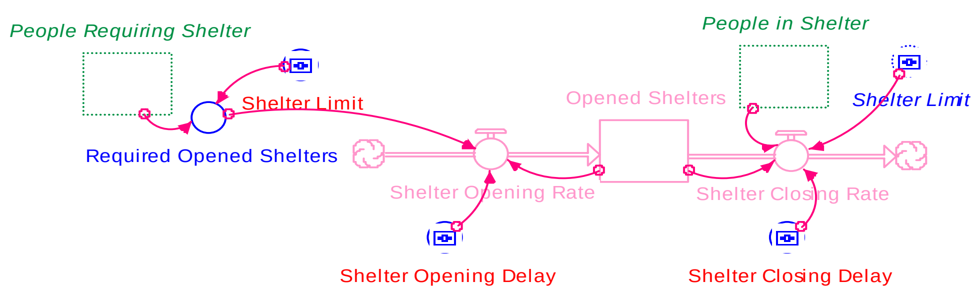


Figure 45. Opened Shelters Stock and Flow Structure. Author's Elaboration, 2008.

- Depending on the "***Meals Limit***" and the "***People in Shelter***", "***Required Meals***" are estimated.

- "***Meals Ready***" depends on the quantity of "***Required Meals***" and "***Meals Available***" by the ARC.

- "***Meals Capacity***" depends on "***DSHR Capacity***" and "***Meals Delivered Limit***"

- Depending on the "***Meals Ready***" and "***Meals Capacity***", "***Meals to be Served***" are estimated.

- Then, "***Meals Incoming Rate***" depends on the "***Meals to be Served***". This flow controls the speed of arriving meals to be served.

- "***Served Meals***" is defined as a stock accumulates where the number of meals flow into it, and a net number of meals flow out of it.

- Therefore, "***Meals Deploying Rate***" depends on the "***Meals to be Served***". This flow controls the deploying of meals (see Figure 46). See appendix F for Equation Definition.

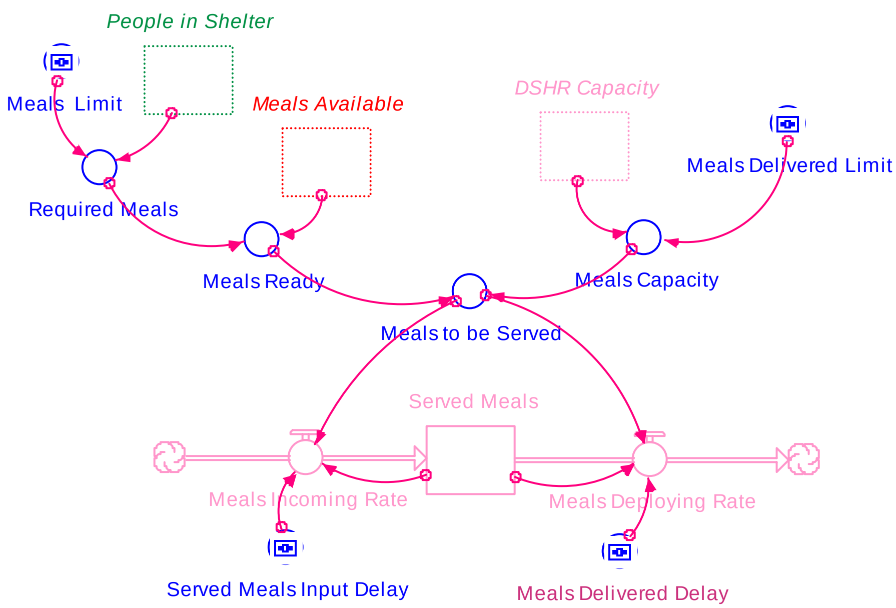


Figure 46. Served Meals Stock and Flow Structure. Author's Elaboration, 2008.

- Depending on the "***Number of Family Group's People per Case***" and the "***People in Shelter***", "***Required Cases***" are estimated.

- "***Cases Processed***" depends on "***DSHR Capacity***" and "***Cases Processed Limit***".

- Depending on the "***Required Cases***" and "***Cases Processed***", "***Cases to be Opened***" are estimated.

- Then, "***Cases Opening Rate***" depends on the "***Cases to be Opened***". This flow controls the speed of cases opening.

- "***Opened Cases***" is defined as a stock accumulates where the amount of cases flow into it, and a net amount of cases flow out of it.

- Therefore, "***Cases Closing Rate***" depends on the "***Cases to be Opened***". This flow controls the closing of cases (see Figure 47). See appendix F for Equation Definition.

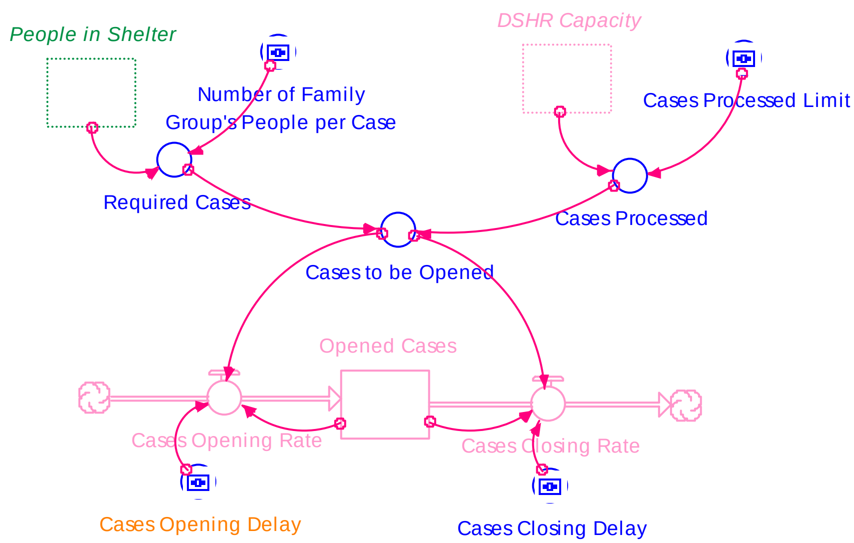


Figure 47. Opened Cases Stock and Flow Structure. Author's Elaboration, 2008.

- Depending on the "***Financial Assistance Limit***" and the "***People in Shelter***", "***Required Financial Assistance***" is estimated.

- "***Financial Assistance Ready***" depends on the quantity of "***Required Financial Assistance***" and "***Financial Assistance Available***" by the ARC.

- "***Financial Assistance Processed***" depends on "***DSHR Capacity***" and "***Financial Assistance Delivered Limit***".

- "***Financial Assistance Delivered Limit***" depends on "***Cases Processed Limit***", "***Number of Family Group's People per Case***" and "***Financial Assistance Limit***".

- Depending on the "***Financial Assistance Ready***" and "***Financial Assistance Processed***", "***Financial Assistance to be Delivered***" are estimated.

- Then, "***Financial Assistance Incoming Rate***" depends on the "***Financial Assistance to be Delivered***". This flow controls the speed of arriving financial assistance to be delivered.

- "***Delivered Financial Assistance***" is defined as a stock accumulates where the amount of financial assistance flows into it, and the net amount of financial assistance flows out of it.

- Therefore, "***Financial Assistance Deploying Rate***" depends on the "***Financial Assistance to be Delivered***". This flow controls the deploying of financial assistance (see Figure 48). See appendix F for Equation Definition.

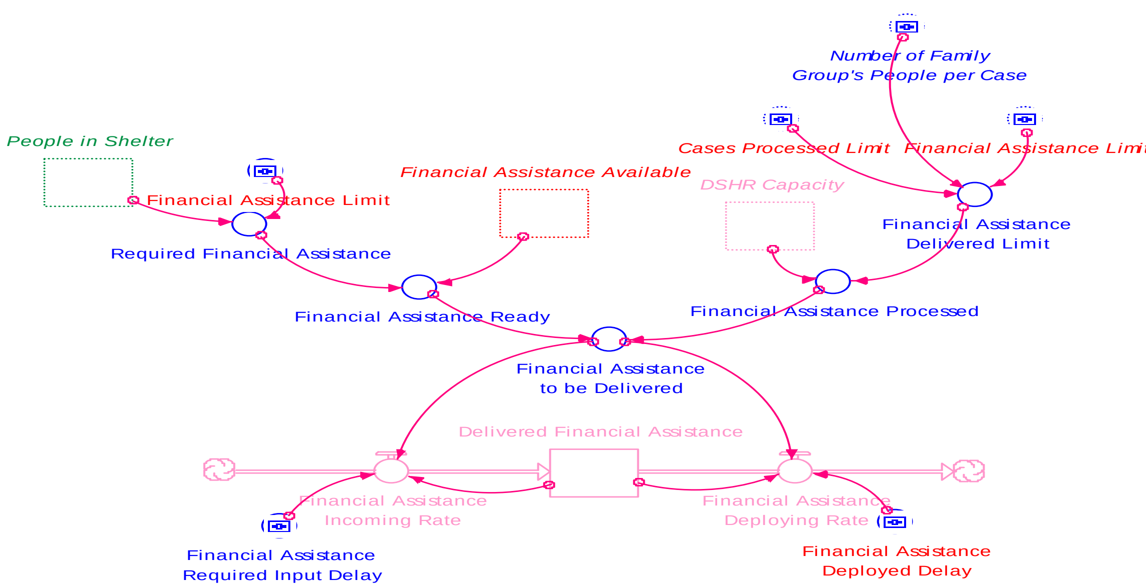


Figure 48. Delivered Financial Assistance Stock and Flow Structure. Author's Elaboration, 2008.

- "***New Volunteers Recruited***" depends on "***Hurricane Level***", "***People with Good Opinion***", "***Potential People for Recruiting***" and "***People with Bad Opinion***".

- "***New Volunteers Recruiting Rate***" depends on the "***New Volunteers Recruited***". This flow controls the speed of new volunteers arriving.

- "***New Volunteers***" is defined as a stock accumulates where the amount of New Volunteers flows into it, and the net amount of New Volunteers flows out of it.

- Therefore, "***New Volunteers Incoming Rate***" controls the arriving of New Volunteers for training.

- "***Staff Capacity***" is defined as stock. Inside of it, is calculated the real "***Staff Availability Proportion***" of "***ARC Staff***" available to assist a relief operation.

- Therefore, "***Staff Incoming Rate***" controls the arriving of Staff Capacity for training.

- "***Volunteers Trained***" is defined as a stock accumulates where the amount of New Volunteers and Staff flows into it, and the net amount of New Volunteers and Staff flows out of it.

- "***DSHR Required***" depends on "***DSHR Limit***", "***People Requiring Shelter***" and "***Shelter Limit***".

- Therefore, "***Volunteers Trained Leaving Rate***" depends on the "***DSHR Required***". This flow controls the deploying of Volunteers Trained.

- "***DSHR Capacity***" is defined as a stock accumulates where the amount of Volunteers Trained flows into it, and the net amount of Volunteers Trained flows out of it.

- Therefore, "***DSHR Deploying Rate***" depends on the "***DSHR Limit***", "***People in Shelter***" and "***Shelter Limit***". This flow controls the deploying of DSHR to the relief operation (see Figure 49). See appendix F for Equation Definition.

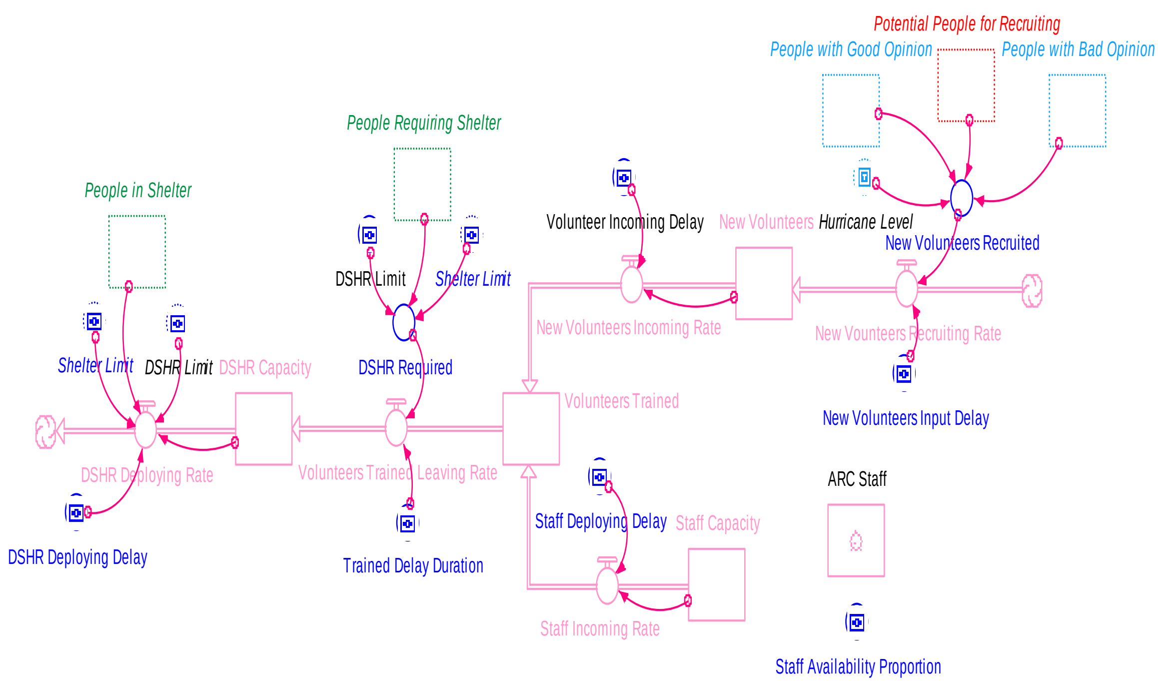


Figure 49. DSHR Capacity Stock and Flow Structure. Author's Elaboration, 2008.

3.10.1.1.3 Emergency Relief System Performance Stock and Flow Structure

In this sector frame of the model are specified the stocks, flows and converters that measures the clients' satisfaction to service received as a result of the interaction of the variables in the affected community subsystem and the system capacity subsystem. It is also modeled the generation of cash flow in order to obtain the necessary funds for financial assistance and the purchase of meals to meet the needs of the people affected by the disaster.

- With the aim of verify whether the people affected by the hurricane obtain the appropriate aid during relief operation, the model compares required and deployed resources.

- Comparison between "***Required Meals***" and "***Served Meals***" show if people affected by hurricane received "***Meals***" during relief operation.

- Comparison between "***Required Financial Assistance***" and "***Delivered Financial Assistance***" show if people affected by hurricane received "***Financial Assistance***" during relief operation.

- Comparison between "***DSHR Required***" and "***DSHR Capacity***" show if people affected by hurricane received "***Mental Health Care***" during relief operation (see Figure 50). See appendix F for Equation Definition.

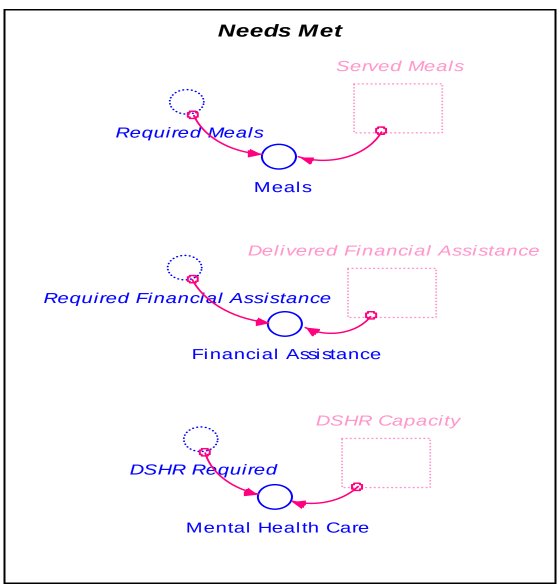


Figure 50. Needs Met Structures. Author's Elaboration, 2008.

- Using CHAID analysis, the likelihood of the client's perception about the service provided by the ARC was estimated as described in section 3.5.

- As a result of the comparison between required and delivered resources perceptions about the service received were estimated.

- Then, "***Good Perceptions***" and "***Bad Perceptions***" of the service provided by ARC were evaluated for people affected by the natural disaster in terms of "***Financial Assistance***", "***Mental Health Care***" and "***Meals***".

- "***Good Perceptions***" is the principal factor for the establishment of the "***Service Quality***". Therefore, perceptions of people about the total service quality provided determine "***Client's Satisfaction***" (see Figure 51). See appendix F for Equation Definition.

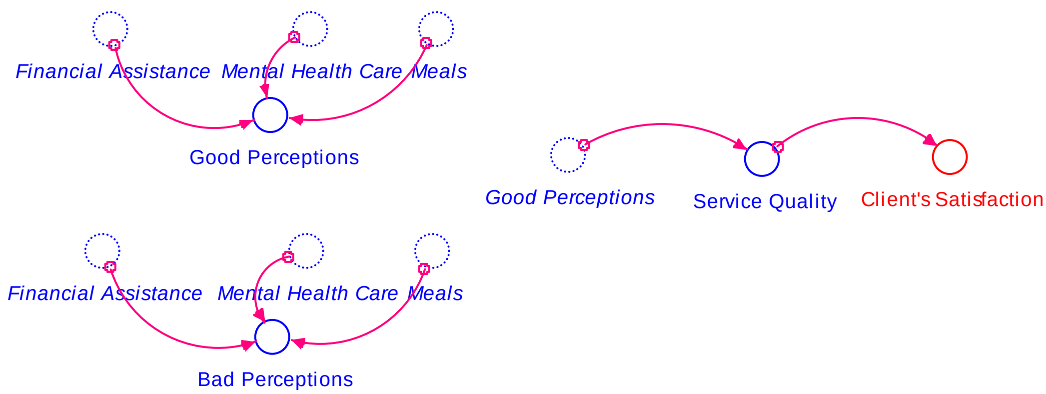


Figure 51. Client's Satisfaction Structure. Author's Elaboration, 2008.

- In the case of a disaster event people of non-affected communities begin to offer aid enrolling as volunteers to assist victims and/or making monetary donation.

- "***Donation Growth Rate***" depends on the "***Donors Proportion***" and the "***Population Over 18 Years Old***". This flow controls the speed of the arriving of "potential people for donation".

- "***Potential People for Donation***" is defined as a stock accumulates where the amount of "potential people for donation" flows into it, and the net amount of "potential people for donation" flows out of it.

- "***Potential People for Donation Death Rate***" depends on the "***Death Rate***" this flow controls the deaths of "potential people for donation".

- "***Weighted People for Donation***" depends on the "***People with Good Opinion***" and "***People with Bad Opinion***".

- "***Donors Rate***" depends on the "***Weighted People for Donation***". This flow controls the speed of the arriving of donor people.

- "***Weighted People for Donation***" depends on "***People with Good Opinion***" and "***People with Bad Opinion***".

- "***Donors***" is defined as a stock accumulates where the amount of donor people flows into it, and the net amount of donor people flows out of it.

- "***Donor Death Rate***" depends on the "***Death Rate***". This flow controls the deaths of "potential donor people".

- "***Recruiting Growth Rate***" depends on the "***Recruiting Proportion***" and the "***Population Over 18 Years Old***". This flow controls the speed of the arriving of "potential people for recruiting".

- "***Potential People for Recruiting***" is defined as a stock accumulates where the amount of "potential people for recruiting" flows into it, and the net amount of "potential people for recruiting" flows out of it.

- "***Recruiting Death Rate***" depends on the "***Death Rate***". This flow controls the deaths of "potential people for recruiting".

- "***Not Eligible Proportion***" depends on the "***Recruiting Proportion***" and the "***Donors Proportion***".

- "***Not Eligible Growth Rate***" depends on the "***Not Eligible Proportion***" and the "***Population Over 18 Years Old***". This flow controls the speed of the arriving of "not eligible population".

- "***Not Eligible Population***" is defined as a stock accumulates where the amount of "not eligible population" flows into it, and net amount of "not eligible population" flows out of it.

- "***Not Eligible Death Rate***" depends on the "***Death Rate***". This flow controls the deaths of "not eligible population" (see Figure 52). See appendix F for Equation Definition.

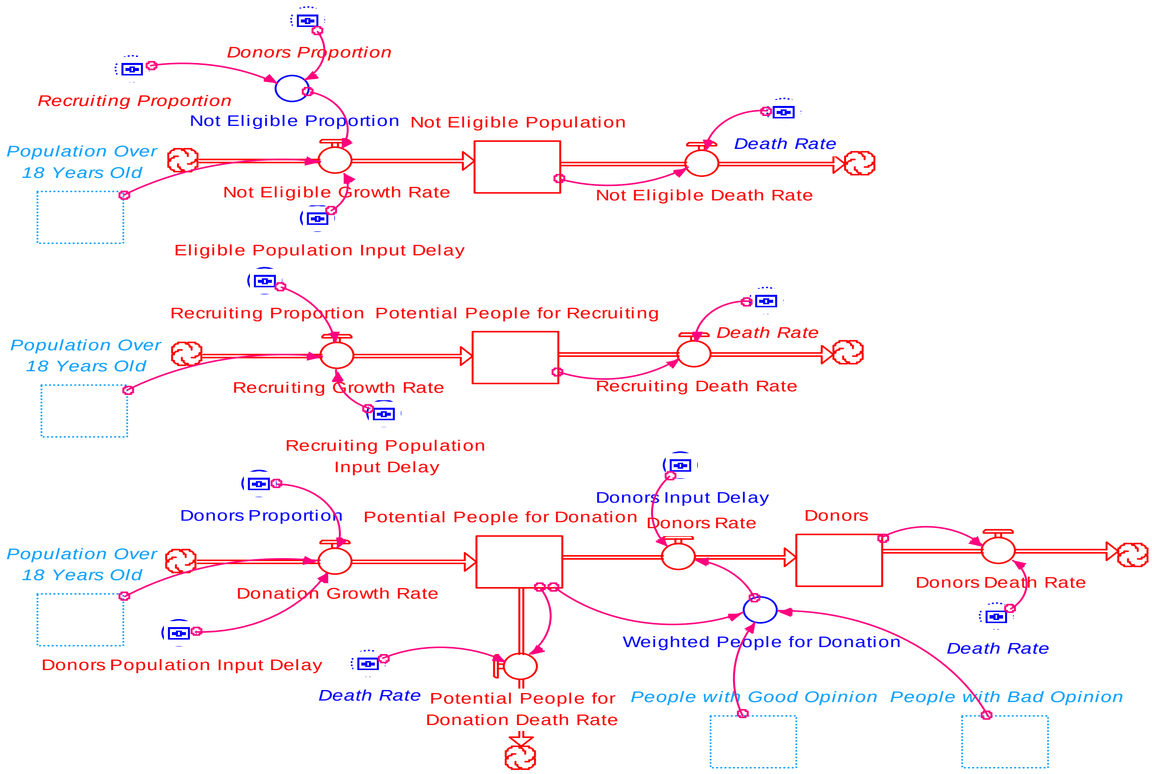


Figure 52. Potential People for Donation Structure. Author's Elaboration, 2008.

- "***Income***" depends on "***Donation per Person***" and "***Donors***". This flow controls the speed of the arriving of cash.

- "***Cash Donations***" is defined as a stock accumulates where the amount of cash flows into it, and the net amount of cash flows out of it.

- "***Expenses***" depend on "***Dollars Spent on Meals***", "***Dollars Spent on Financial Assistance***" and "***Dollars Spent on Others***". This flow controls the deploying of cash to be spent in meals and financial assistance during the relief operation.

- "***Dollars Spent on Financial Assistance***" depends on "***Cash Donations***" and "***Financial Assistance %***".

- "***Financial Assistance Input Rate***" depends on "***Dollars Spent on Financial Assistance***". This flow controls the speed of the arriving of financial assistance.

- "***Financial Assistance Available***" is defined as a stock accumulates where the amount of financial assistance flows into it, and the net amount of financial assistance flows out of it. The initial value is provided by "***Financial Assistance Fund***".

- "***Dollars Spent on Meals***", depends on "***Cash Donations***" and "***Meals %***".
- "***Meals Purchased Input Rate***" depends on "***Dollars Spent on Meals***" and "***Price per Meal***". This flow controls the speed of the arriving of Meals.
- "***Meals Purchased***" is defined as a stock accumulates where the amount of "meals purchased" flows into it, and the net amount of "meals purchased" flows out of it.
- "***Meals Purchased Output Rate***" controls the speed of the outflow of "Meals Purchased".
- "***Meals Available***" is defined as a stock accumulates where the amount of "Meals Available" flows into it, and the net amount of "Meals Available" flows out of it. The initial value is provided by "***Meals Stored***".
- "***Dollars Spent on Others***" depends on "***Cash Donation***" and "***Others %***" (see Figure 53). See appendix F for Equation Definition.

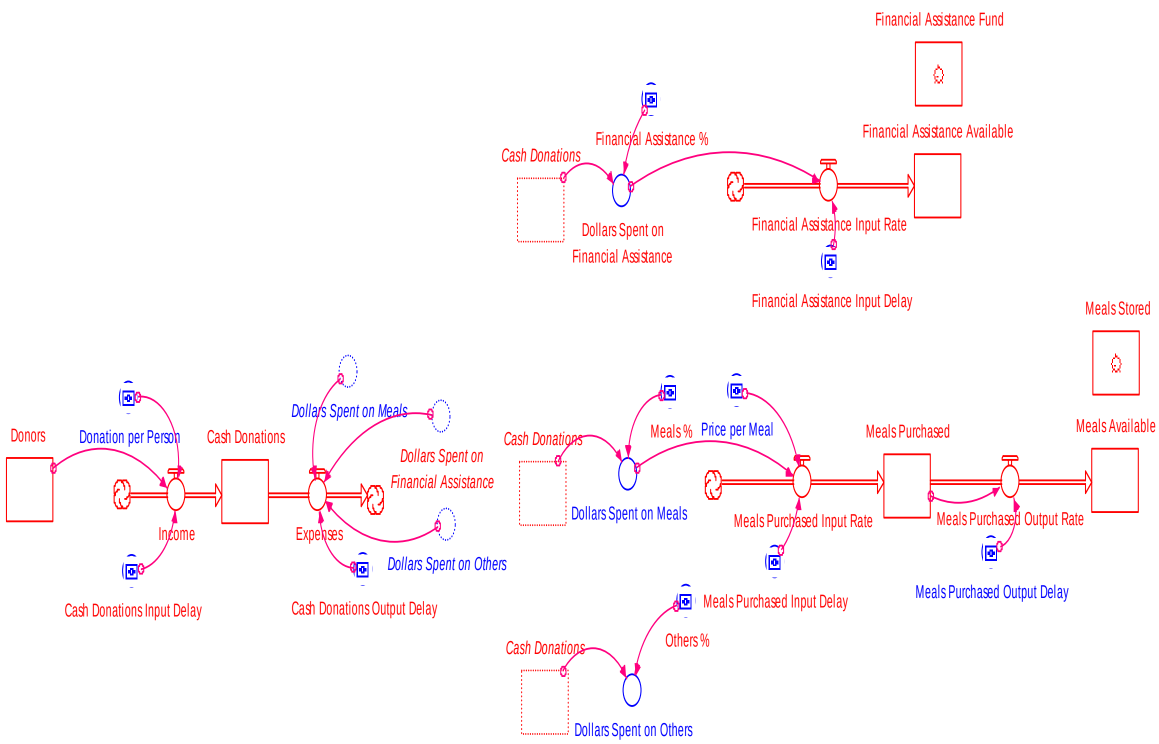


Figure 53. Cash Donation Structure. Author's Elaboration, 2008.

3.10.1.1.4 External Factors Stock and Flow Structure

In this sector frame of the model the converters that describe the demographic characteristics and profile of the population affected are specified. It also describes the structure for the spreading of news that will affect the reputation of the relief organization (in this case, the ARC)

- "***Hurricane Threaten***" is a switch that remains in ON mode to begin the simulation if there is any hurricane event (see Figure 54).

Figure 54. Hurricane Threaten Push Button. Author's Elaboration, 2008.

- "***Hurricane Level***" is a switch that indicates using ON/OFF if the hurricane event is high or Low (see Figure 55).

Figure 55. Hurricane Level Push Button. Author's Elaboration, 2008.

- "***Birth Rate***" depends on "***Births***". This flow controls the speed of population's births daily in the United States.

- "***Total Census Population***" is defined as a stock that accumulates where the number of people flows into it, and the net number of people out of it.

- "***Death Rate***" depends on "***Deaths***". This flow controls the speed of population's deaths daily in the United States.

- The structure described above represents the growth and death of Unites States population and it is used to generate the quantity of people over 18 years old in the United States.

- "***Population Over 18 Years Old Growth Rate***" depends on "***Population Proportion Over 18 Years Old***". This flow controls the speed of generation of population with 18 years old or more in the United States.

- "***Population Over 18 Years Old***" is defined as a stock accumulates where the number of people with 18 years old or more flows into it, and the net number of people with 18 years old or more out of it.

- "***Population Over 18 Years Old Death Rate Deaths***". This flow controls the speed of deaths in population over 18 years old or more in the United States (see Figure 56). See appendix F for Equation Definition.

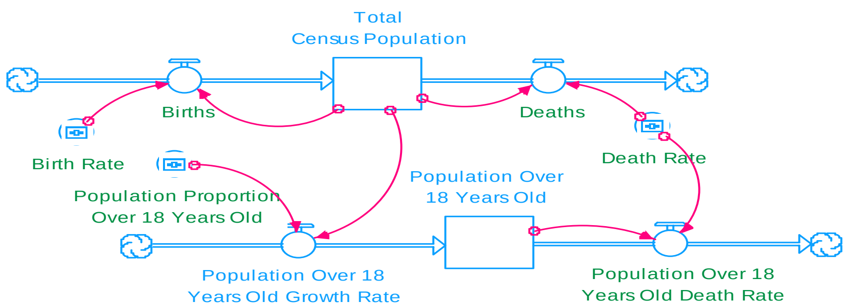


Figure 56. United States Population Structure. Author's Elaboration, 2008.

- "***House Ownership Status Census: Other***" depends on "***House Ownership Status Census: Own***, ***House Ownership Status Census: Rent***" and "***House Ownership Status Census: Live with Parents***".

- "***Household Income Census: More Than 10 K and Own***" depends on "***Household Income Census: Less than 10 K and Own***".

- "***Race Non White Income More Than 10 K Less Than 40K Renter***" depends on "***Race Non Hispanic White Income More Than 10 K Less Than 40K Renter***".

- "***Household Income Census: More Than 30K Less Than 40K***" depends on "***Household Income Census: Less than 10 K and Rent***" and "***Household Income Census: More Than 10 K Less Than 40K and Rent***" (see Figure 57). See appendix F for Equation Definition.

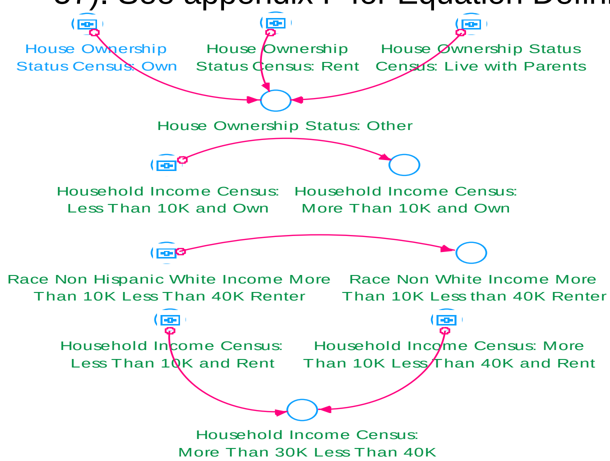


Figure 57. Client's Demographic Characteristics and Profile Structure. Author's Elaboration, 2008.

The following structure describes the spread of news based in the logic used in the dynamics of epidemics.

- "***Neutral opinion Incoming Rate***" depends on "***Shelter Incoming Rate***" and "***People in Shelter***". This flow controls the speed of arriving of neutral opinion proportion.

- "***People with Neutral Opinion***" is defined as a stock accumulates where the amount of neutral opinion proportion flows into it, and the net amount of neutral opinion proportion flows out of it.

- Then, "***Neutral Opinion Leaving Rate***" depends on the "***Shelter Leaving Rate***", "***People in Shelter***" and "***People in Shelter Relative Changing Rate***". This flow controls the exit of neutral opinion proportion.

- "***Media Good News Spread Rate***" depends on "***Good News Spread Rate***".

- "***Good Opinion Spread Rate***" depends on "***Media Good News Spread Rate***". This flow controls the speed of arriving of good opinion proportion.

- "***People with Good Opinion***" is defined as a stock accumulates where the amount of good opinion proportion flows into it, and the net amount of good opinion proportion flows out of it.

- "***Good Opinion Leaving Rate***" depends on "***People in Shelter***", "***Shelter Leaving Rate***" and "***People in Shelter Relative Changing Rate***". This flow controls the exit of good opinion proportion.

- "***Media Bad News Spread Rate***" depends on "***Bad News Spread Rate***.

- "***Bad Opinion Spread Rate***" depends on "***Media Bad News Spread Rate***". This flow controls the speed of arriving of bad opinion proportion.

- "***People with Bad Opinion***" is defined as a stock accumulates where the amount of bad opinion proportion flows into it, and the net amount of bad opinion proportion flows out of it.

- "***Bad Opinion Leaving Rate***" depends on "***Shelter Leaving Rate***", "***People in Shelter***" and "***People in Shelter Relative Changing Rate***". This flow controls the exit of bad opinion proportion (see Figure 58). See appendix F for Equation Definition.

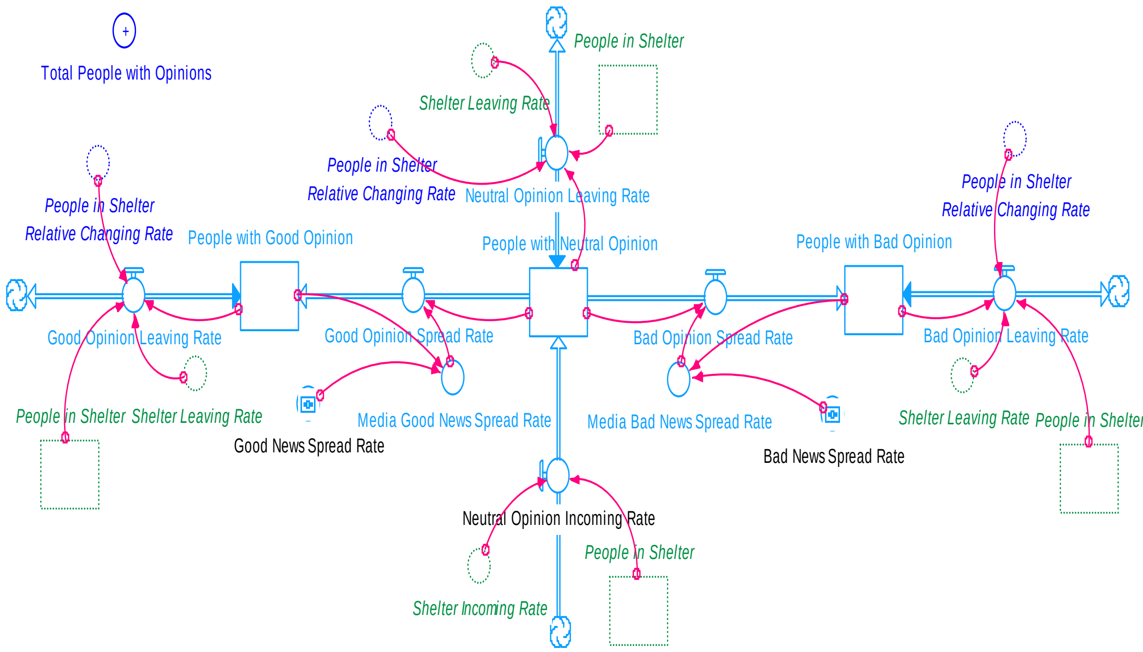


Figure 58. Spread of News Structure. Author's Elaboration, 2008.

This structure for the spread of news is conceptual and dimensionally correct when it is simulated for the behavior of shelter incoming rate and shelter leaving rate. It means that total values of "People with Neutral Opinion", "People with Good Opinion" and "People with Bad Opinion" always sum to 1 and stabilizes at the end of the simulation in a value that can be compared to the opinion survey of the ARC to calibrate the parameters of "Good and Bad News Spread Rates".

It is important to notice that the model simulates correctly if it is considered a $dt < \frac{1}{64}$. This structure does not run well if a $dt = 1$ is used. Seen mathematically the model is a differential equations system, therefore, this is not strange, this happens.

3.10.1.2 Specification of Decision Rules

Specifications of human decisions were determined for the model by the use of mathematical functions (decision rules). The decision rules represented in the model structure were:

- "Shelter Incoming Rate": The arriving of people to the shelters is a function of the speed of opening shelters and the capacity of each shelter.

- “Shelter Leaving Rate”: The leaving of people from the shelters is a function of the speed of opening cases.

- “Shelter Limit”: Shelter capacity is 300 people.

- “Shelter Closing Rate”: The closing of shelters is a function of the quantity of opened shelters and the number of people that stay inside them.

- “Meals Limit”: The quantity of served meals per person per day is three.

- “Meals Incoming” and “Deploying Rate”: The deployment of meals is a function of the DSHR and the number of meals these personnel can serve.

- “Cases Opening” and “Closing Rate”: The processing of cases is a function of the DSHR and the number of cases these personnel can handle.

- “Financial Assistance Incoming” and “Financial Assistance Deploying Rate: The deliver of financial assistance is a function of the DSHR and the amount of financial aid these personnel can handle.

- “ARC Staff”: The American Red Cross count with 30,000 staff people in stand-by to serve in a relief operation.

- “DSHR Limit”: Shelters with 300 or more residents may need to add one to three workers to each shelter. The suggested minimum number to set up and operate a kitchen site is 48. Then, 51 DSHR is the minimum a relief operation needs in order to deliver meals, assist shelters, deliver financial assistance and open cases.

3.10.1.3 Estimation of Initial Conditions

Simulation runs for the model were made with the following parameters:

- Simulation Control Parameters
- User Defined Parameters

3.10.1.3.1 Simulation Control Parameters

- Length of Simulation: From 0 to 27 days. This time horizon corresponds to the duration of the Katrina Hurricane Operation and would correspond to a large disaster operation. For another disaster, a different time horizon would have been used.

- Interval of Time between calculations: DT = 1.0 day.

3.10.1.3.2 User Defined Parameters

Initial values used in this model, a brief definition of them and the source that provided the information are specified in Tables 11, 12, 13, 14 and 15.

Table 11. User Defined Parameters: Katrina Relief Operation. Author's Elaboration, 2008.

Component of SQRC	Variable Name	Definition	Initial Value	Source
External Factors	Birth Rate	The ratio of total live births to total population in the United States over a day.	0.00004	Central Intelligence Agency.
	Death Rate	The ratio of total deaths to total population in the United States over a day.	0.00002	Central Intelligence Agency.
	Population Proportion Over 18 Years Old	Proportion of people who live in the United States and are over 18 years old.	0.00203	Central Intelligence Agency.
	Hurricane Threaten	A 0-1 rating used to indicate there is a potential hurricane event and the simulation can begin.	ON=1	Defined by the Programmer.
	Hurricane Level	A 0-1 rating based on the hurricane's present intensity. High Level (On=1): Category Four and Five Hurricane. Low Level (Off=0): Category One, Two, Three, Tropical Storm and Tropical Depression.	ON=1	Defined by the Programmer.
	House Ownership Status Census: Own	Proportion of people who are homeowners.	0.7596	United States Census Bureau.
	House Ownership Status Census: Rent	Proportion of people who are renters of realty.	0.2123	United States Census Bureau.
	House Ownership Status Census: Live with Parents	Proportion of people who live with their parents.	0.0256	United States Census Bureau.
	Household Income Census: Less Than 10K and Own	Proportion of people whose current private income is less than $10,000 and are owners of realty.	0.0950	United States Census Bureau.

Table 12. User Defined Parameters: Katrina Relief Operation. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Initial Value	Source
External Factors	Household Income Census: Less Than 10K and Rent	Proportion of people whose current private income is less than $10,000 and use rent realty.	0.7620	**United States Census Bureau.**
	Household Income Census: More Than 10K Less Than 40K and Rent	Proportion of people whose current private income is more than $10,000 but less than 40K and use rent realty.	0.1460	**United States Census Bureau.**
	Race Non Hispanic White Income More Than 10K Less Than 40K Renter	Proportion of people who self-identified as Non Hispanic White; whose income is more than $10,000 and less than $40,000, and are renters of realty.	0.1520	**United States Census Bureau.**
	Good News Spread Rate	Speed of Good News dissemination by the Media. (Value estimated when the structure reach the steady state).	0.7	**Defined by the Programmer.**
	Bad News Spread Rate	Speed of Bad News dissemination by the Media. (Value estimated when the structure reach the steady state).	0.8	**Defined by the Programmer.**
Affected Community	Total Population Affected (LA, MS, AL)	People who live in the United States and were influenced by the struck of the hurricane.	711,698	**CRS (Congressional Research Services).**
	People in Shelter	Amount of people evacuated and accommodated in shelters. (Initial value used to avoid division by zero).	10	**Defined by the Programmer.**
System Capacity	Shelter Limit	Maximum number of people that a shelter can contain (in person/unit).	300	**American Red Cross.**
	Shelter Opening Delay	**Numbers of days that the rate of opening shelters was postponed.**	**1**	**Disaster Operation Summary Reports.**

Table 13. User Defined Parameters: Katrina Relief Operation. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Initial Value	Source
System Capacity	Shelter Closing Delay	Numbers of days that the rate of closing shelters was postponed.	1	**Disaster Operation Summary Reports.**
	Meals Limit	Maximum quantity of food served per person (in unit/person).	11	**American Red Cross.**
	Served Meals Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Meals Delivered Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Meals Delivered Limit	Maximum quantity of food served per DSHR people (in unit/person).	188	**American Red Cross.**
	Cases processed Limit	Maximum quantity of cases processed per ARC Human Resources people (in unit/person).	21	**American Red Cross.**
	Number of Family Group' People per Case	Maximum number of people contained in a family. Each family constitutes a case (in person/unit).	4	**United States Census Bureau.**
	Cases Opening Delay	Number of days a client waits for the opening of his case by the ARC personnel.	1	**Disaster Operation Summary Reports.**
	Cases Closing Delay	Number of days a client waits for the closing of his case by the ARC personnel.	1	**Disaster Operation Summary Reports.**
	Financial Assistance Limit	Maximum amount of financial assistance delivered per person (in USD/person).	250	**American Red Cross.**
	Financial Assistance Required Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Financial Deployed Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	ARC Staff	A group of assistants of the American Red Cross (in person).	30,000	**American Red Cross.**
	Staff Availability Proportion	**Proportion of the ARC Staff Ready for relief operation.**	**0.1**	**American Red Cross.**

Table 14. User Defined Parameters: Katrina Relief Operation. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Initial Value	Source
System Capacity	Staff Deploying Delay	Numbers of days postpone Staff' deploying.	1	**Disaster Operation Summary Reports.**
	New Volunteers Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Volunteer Incoming Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Trained Delay Duration	Numbers of days of duration employed in volunteers training.	5	**American Red Cross.**
	DSHR Limit	Maximum number of ARC Human Resources that a relief operation need to assist shelters and operate a kitchen site (in person/unit).	51	**American Red Cross.**
	DSHR Deploying Delay	Numbers of days postpone DSHR' deploying.	1	**Disaster Operation Summary Reports.**
Emergency Relief System Performance	Eligible Population Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Recruiting Proportion	Proportion of people selected to be volunteers.	0.02	**American Red Cross.**
	Recruiting Population Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Donors Proportion	Proportion of people that contributes to the disaster relief cause.	0.00194	**American Red Cross.**
	Donors Population Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Donors Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Donation per Person	Amount of money giving per person to help hurricane's victims (in USD/person).	29.78	**American Red Cross.**
	Cash Donations Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Cash Donations Output Delay	**Mathematical delay (in days). For unit consistency purpose.**	**1**	**Defined by the Programmer.**

Table 15. User Defined Parameters: Katrina Relief Operation. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Definition	Initial Value	Source
Emergency Relief System Performance	Meals %	Percentage of the cash donations designated for the food purchase during the relief operation.	8	**American Red Cross.**
	Financial Assistance %	Percentage of the cash donations designated for the client assistance cards during the relief operation.	68	**American Red Cross.**
	Others %	Percentage of the cash donations designated for the purchase of kits and snacks during the relief operation.	24	**American Red Cross.**
	Meals Stored	Quantity of food reserved for future use during relief operation (in units).	1,000,000	**American Red Cross.**
	Price per Meal	Average cost of meal served during relief operation (in USD/unit).	5	**American Red Cross.**
	Meals Purchased Input Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Meals Purchased Output Delay	Mathematical delay (in days). For unit consistency purpose.	1	**Defined by the Programmer.**
	Financial Assistance Funds	Assets in the form of money that the ARC destines to assist victims in case of a disaster (in USD).	10,000	**American Red Cross.**
	Financial Assistance Input Delay	**Mathematical delay (in days). For unit consistency purpose.**	**1**	**Defined by the Programmer.**

3.10.1.4 Tests for Consistency with the Purpose and Boundary

Tests to undercover flaws in the suggested formulation and improve the model were made with the use of test for Boundary Adequacy. With this it was possible to establish that the main concepts for addressing the problem were endogenous to the model.

With the subsystem diagrams, causal diagrams, stock and flow maps, and direct inspection of model equation, it was possible to confirm that the variables used in this model were properly considered.

3.11 EQUATION DEFINITION

The system description of the simulation model was converted into stock and flow equations of the system dynamic model. The equations describe the relationships between variables and were generated as part of the modeling process (see appendix F).

4 RESULTS

"Let's just say I was testing the bounds of reality. I was curious to see what would happen. That's all it was: curiosity".

-- Jim Morrison --

This chapter illustrates the final steps for model development and validation as well as the simulation results obtained after finishing the process of model's creation.

This chapter is organized as follows: Section 1, presents model testing; Section 2, describes the use and interpretation of the model; Section 3, exhibits key variables in the Katrina operation estimated by "other sources" vs. SQRC model results; Section 4, presents policy design and evaluation; Section 5, explains the model verification process; Section 6, describes the model validation process; Section 7, explains expert consultation of this research work.

4.1 TESTING

In order to confirm that the model has been correctly implemented to satisfy the proposed objective, it is necessary to test the model beyond its boundaries, also with the aim to determine the model's useful field of applicability (Sterman, 2000). The following steps are needed to carry out this task.

4.1.1 Model Structure Tests

4.1.1.1 Dimensional Consistency

In order to identify units' errors inside the model, every equation was inspected. Parameters with meaningless names, strange combinations of units, or dimensionless parameters with values of unity were discarded. Inside the model in Stella™ has the command *Enforce Unit Consistency* as a default setting.

4.1.1.2 Robustness under Extreme Conditions

According to Sterman (2000), a dynamic model should be tested for robustness under extreme conditions to show that the model behaves appropriately when the inputs take on extreme values such as zero or infinity.

Two key variables from different areas of the model have been selected for this test. Each variable is tested at the minimum level defined for them, therefore the results are analyzed for accurate logic and correct behavior of the model.

Two sets of graphs are used to analyze the results: Total Population Affected and Recruiting Proportion combined with Staff Availability Proportion.

Both graphs summarize the time series behavior of key variables that govern the model for the whole 27 days that are being simulated. It was revealed that the model performs in a realistic way while under pressure during extreme conditions.

<u>Total Population Affected</u>

Population affected, has an important impact on the behavior of the model. It is also a credible and predictable variable since it is possible to anticipate what happens when there are no people affected in case of disaster. Population affected, represents the population living in the areas affected by the hurricane.

This graph presents three key variables (see Figure 59). The X-axis has the time of the simulation in days. The Y-axis represents the value of the key variables at each time.

To interpret the graph properly, review the range of values for each variable on the Y-axis.

Figure 59. Extreme Condition Test: Zero "Population Affected". Author's Elaboration, 2008.

This graph presents four key variables. The X-axis has the time of the simulation in days.

Running the model without *Population Affected* per day, equates to zero for *Shelter incoming*, *Shelter Leaving Rate* and *People in Shelter*.

In the same way, *Opened Shelters*, *Served Meals*, *Opened Cases* and *DSHR Capacity* stay consistently at zero. This first test is successful, since the model behaves with logic and gives results that were expected.

Recruiting Proportion and Staff Availability Proportion

Recruiting Proportion and Staff Availability Proportion are two variables with high impact on the behavior of the model. It is possible to anticipate what happens to DSHR Capacity when there are not people for recruiting and available staff: people cannot leave shelters, no meals are deployed and no cases are opened.

This graph presents one key variable (see Figure 60). The X-axis has the time of the simulation in days. The Y-axis represents the value of the key variable at each time.

To interpret the graph properly, review the range of values for each variable on the Y-axis.

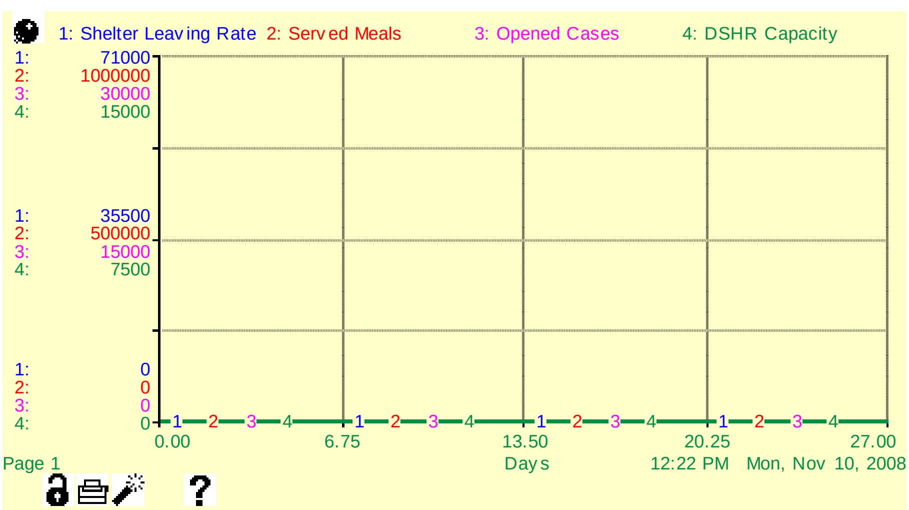


Figure 60. Extreme Condition: “Recruiting Proportion” and “Staff Availability Proportion”. Author’s Elaboration, 2008.

4.1.2 Model Behavior Tests

4.1.2.1 Comparison to Reference Modes

This is probably one of the most important tests for any model, but particularly a dynamic model, since the objective of all models is to mimic reality. It is essential to make a comparison with real life results to see if it closely resembles the behavior of the key variables. To achieve this contrast, the study of the actual behavior of the system was compared with the simulated behavior of the model. Therefore, every variable was proven for coherence to a significant concept in the real world.

Figure 61, Figure 62, Figure 63, Figure 64, Figure 65, Figure 66 and Figure 67 shows the comparison between real and simulated data for the model runs. The blue line represents the real behavior of each key variable during relief operation of Katrina hurricane (at least as reported by the ARC); and the red line represents the results of the model simulation.

The X-axis has the time of the simulation in days. The Y-axis represents the value of the key variable both simulated and real at each time.

Graphs for key variables suggest an acceptable behavior between the simulation and real data. Both graphics follow a similar pattern of behavior. Data points of the simulation remain in a similar range in comparison to the real data.

Because of the enormous fluctuations presented by the real data reported by the ARC, a smoothing method was applied with the objective of diminishing the noise of the data set. A smoothing procedure will change (soften) the fluctuations to represent a smooth curve instead that follow the trends of the behavior.

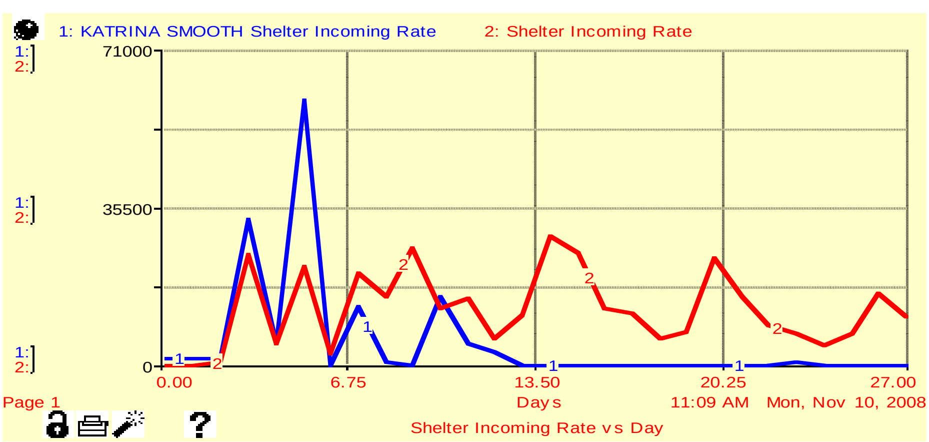


Figure 61. "Shelter Incoming Rate": Reference Mode vs. Simulation. Author's Elaboration, 2008.

The real data for “Shelter Incoming Rate” ranged from 0 to nearly 60,098 people per day on the 4th day. The simulation shows data ranged from 0 to 29,100 people. For this key variable simulation runs decrease to zero on the 69th day.

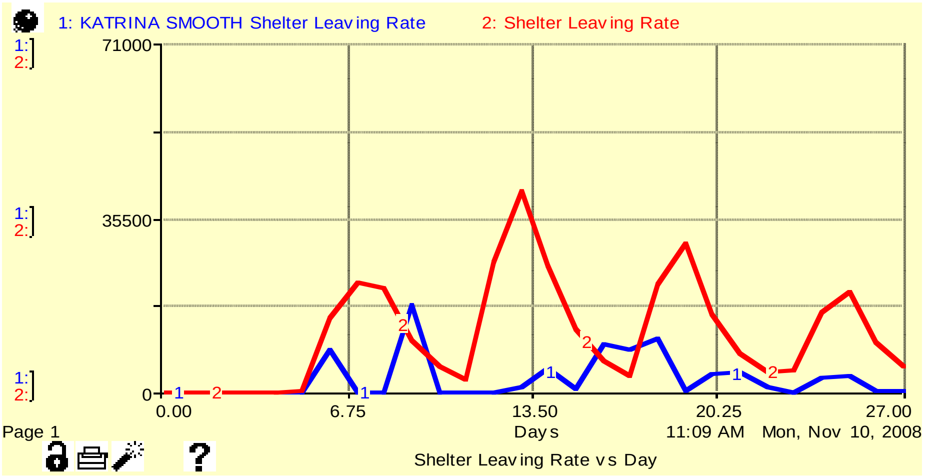


Figure 62. “Shelter Leaving Rate”: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

The real data for “Shelter Leaving Rate” ranged from 0 to nearly 17,784 people. The simulation shows data ranged from 0 to 41,292 people.

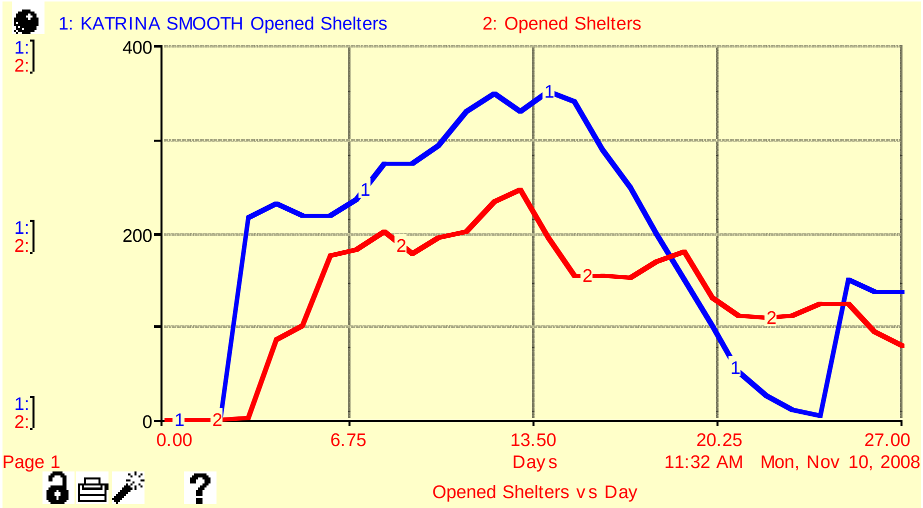


Figure 63. “Opened Shelters”: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

In real data “Opened Shelters” ranged from 0 to nearly 352 units. Simulation shows data ranged from 0 to 246 units.

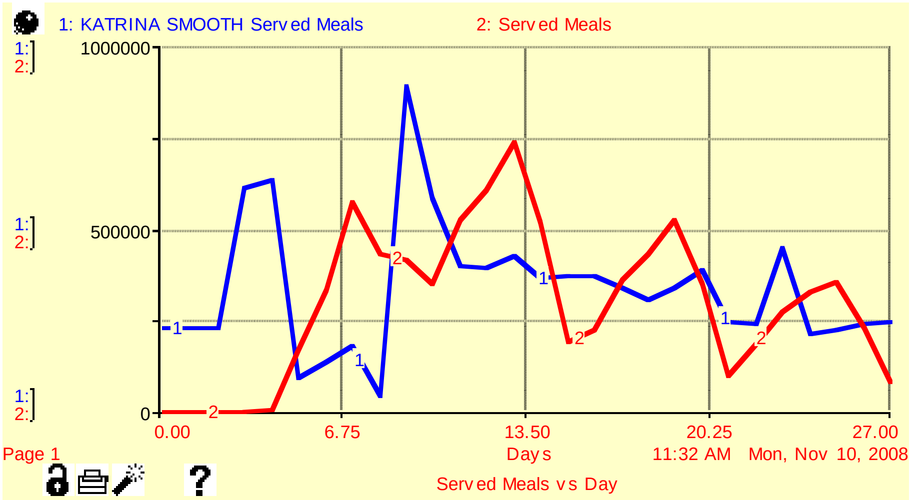


Figure 64. “Served Meals”: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

In real data “Served Meals” ranged from 0 to nearly 895,503 units. Simulation shows data ranged from 0 to 743,429 units.

Data obtained for served meals was from the beginning somewhat suspicious because it was obvious that meals provided to people outside the shelters was reported in the same column without distinction.

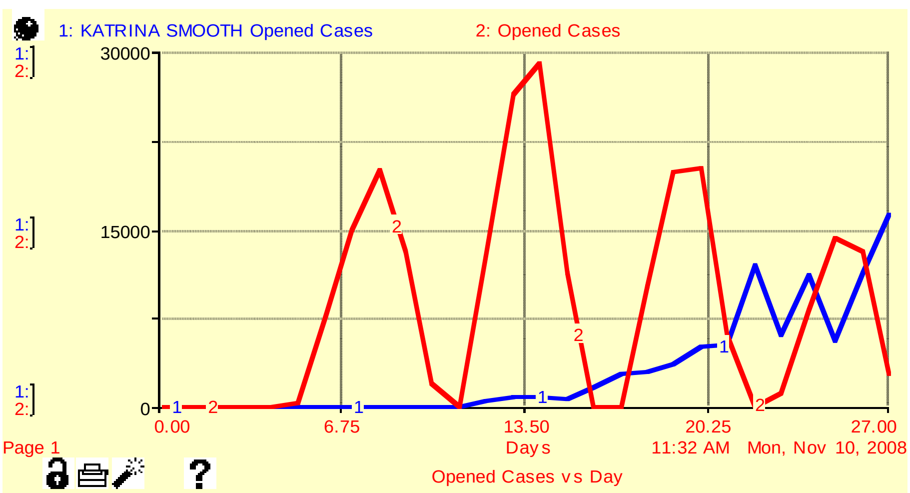


Figure 65. “Opened Cases”: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

In real data “Opened Cases” ranged from 0 to nearly 16,200 cases. Simulation shows data ranged from 0 to 29,210 cases.

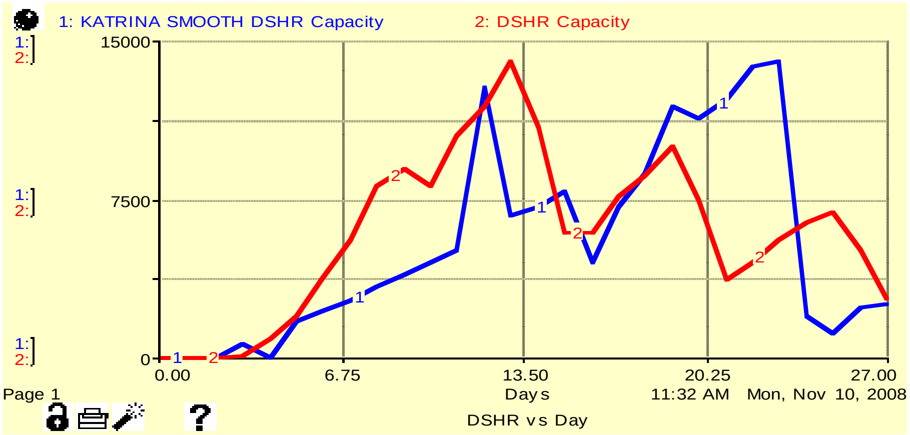


Figure 66. “DSHR”: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

In real data reports, “DSHR Capacity” personnel ranged from 0 to nearly 14,067 people. Simulation results shows DSHRs ranged from 0 to 14,093 people.

For the key variable “Opened Cases” it can be seen that the behavior of the simulation doesn’t follow the same pattern as the reference mode. That is, because there are 11 days for which the report of data provided by the ARC for the relief operation is lacking this variable. The number of people that leave a shelter represented by the variable “Shelter Leaving Rate” depends directly on “Opened Cases”. “Shelter Leaving Rate” shows outflows of people beginning the 6th day. The number of staff in charge of processing the cases is represented by the variable “DSHR Capacity”. DSHR personnel were being deployed from the 3rd day of the relief operation. The simulated variable “Opened Cases” shows the processing of cases from the 5th day, which is consistent with the departure of people in shelters and the DSHR assigned to the relief operation.

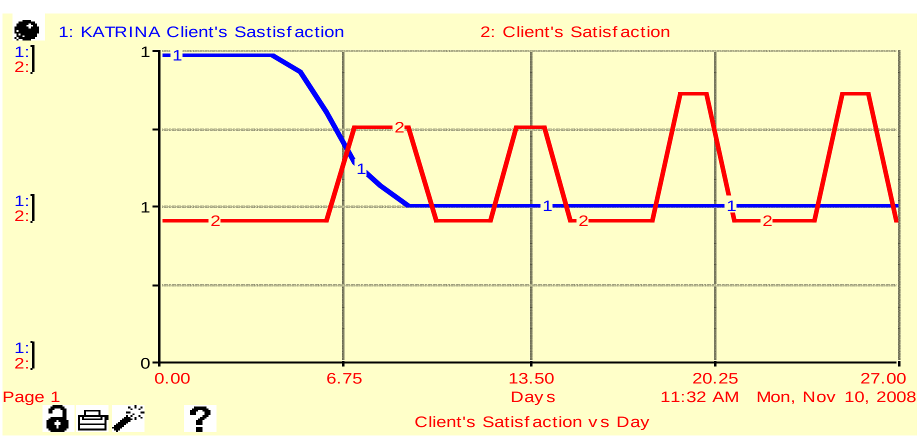


Figure 67. “Client's Satisfaction”: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

This behavior was assumed. In the Katrina reference mode it was presumed that the satisfaction of people diminishes each day during the relief operation, based in news reports of abuse and violence inside the ARC shelters.

It can be corroborated by SPSS AnswerTree™ analysis that at its lowest, 79.6% of the people in shelters had a good perception of the service received by the ARC during the relief operation in terms of financial assistance, mental health care and food provided (see Figure D-3).

The simulated model shows that “Client’s Satisfaction” presented several fluctuations over time. It means there were periods during relief operation were people experienced a high level of satisfaction: an 86.58% maximum percentage value of satisfaction was reached (see appendix G).

4.1.3 Additional Tests

4.1.3.1 Integration Error Test

The use of a finite time step and the resulting approximation to the average rates over the interval, introduce an error known as: *Integration Error* or *dt Error* (Sterman, 2000).

Integration tests were accomplished to check for the model’s sensitivity to the selection of the simulation time step. This test assumes that even if the time step changes, the behavior of the model will not change significantly.

Time steps one-fourth to one-tenth as large as the smallest time constant in the model were selected. Therefore, the simulation was run with time steps of 0.1, 0.125 and 0.25 days. With the choosing of this time step it was ensuring that those were divisible into the interval between data points.

Euler’s Method for integration was chosen to run these tests because this method is almost always fine in models of social systems where there are large error in parameters, initial conditions, historical data, and especially model structure.

<u>Time Step: 0.1 Days</u>

The first simulation was run at an Integration Time Step of 0.1 days. The results obtained for “Shelter Incoming Rate” and “Shelter Leaving Rate” are shown below (see Figures 68 and 69).

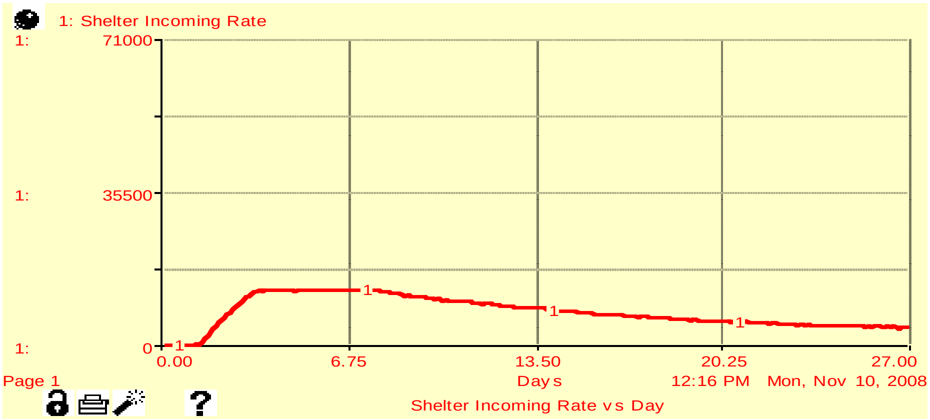


Figure 68. "Shelter Incoming Rate" for a Simulation Run with the Integration Time Step=0.1 days. Author's Elaboration, 2008.

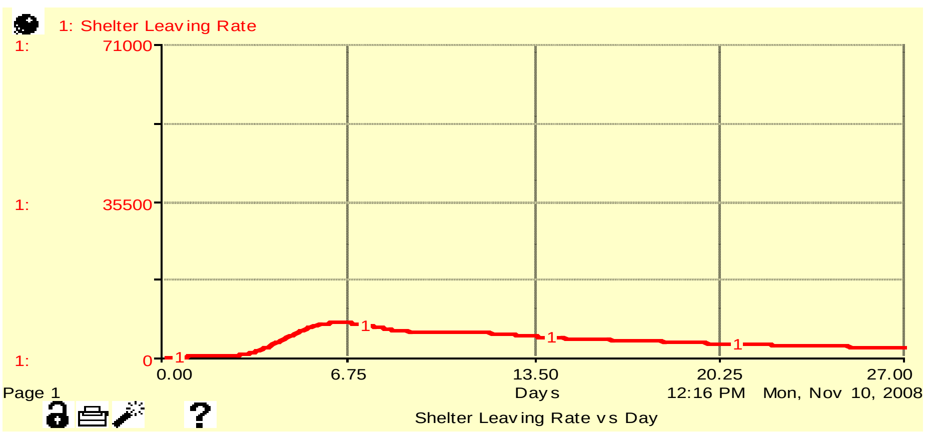


Figure 69. "Shelter Leaving Rate" for a Simulation Run with the Integration Time Step=0.1 days. Author's Elaboration, 2008.

The data provided by Red Cross for the disaster relief operation has a discrete behavior because the time step is distributed day by day in integer days. Reducing DT from 1 to 0.1, the software is adding information that there is not exist, because it is interpolating and estimating a new data set. The same behavior is exhibit for these key variables using DT of 0.125 and 0.25.

<u>Time Step: 0.125 Days</u>

The second simulation was run at an Integration Time Step of 0.125 days. The results obtained for "Shelter Incoming Rate" and "Shelter Leaving Rate" (see Figures 70 and 71).

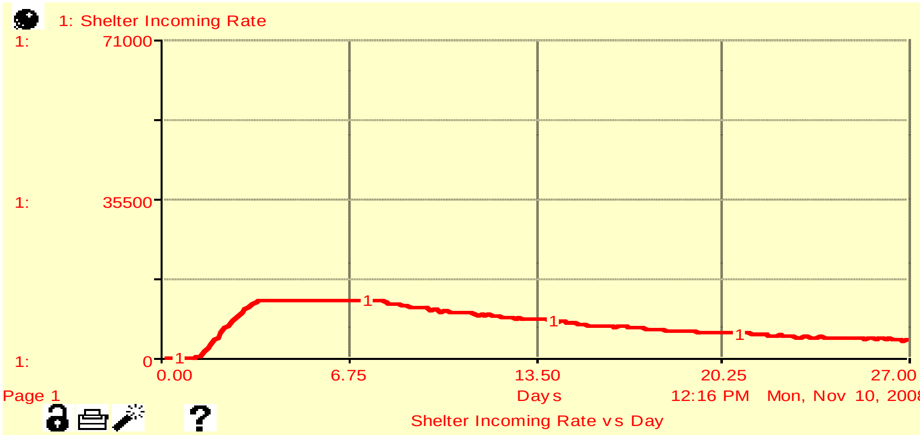


Figure 70. “Shelter Incoming Rate” for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008.

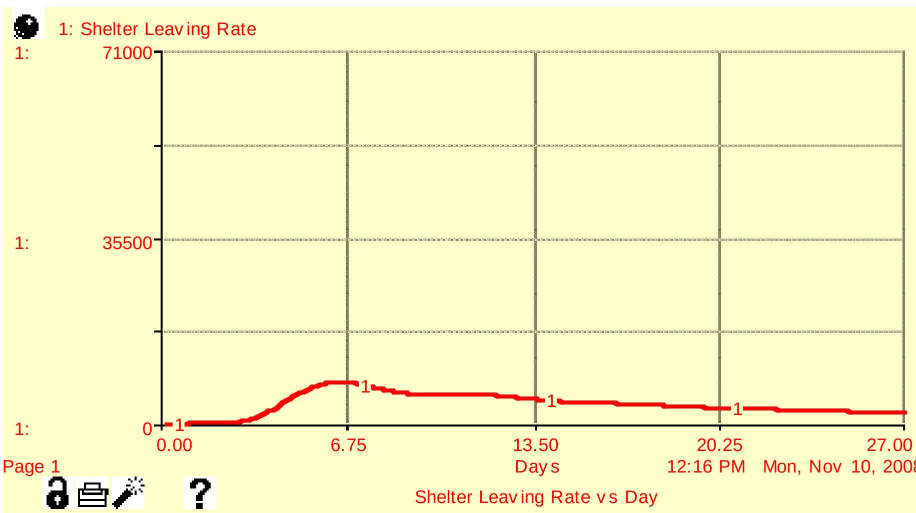


Figure 71. “Shelter Leaving Rate” for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008.

<u>Time Step: 0.25 Days</u>

The third simulation was run at an Integration Time Step of 0.25 days. 125 days. The results obtained “Shelter Incoming Rate” and “Shelter Leaving Rate” are shown below (see Figures 72 and 73).

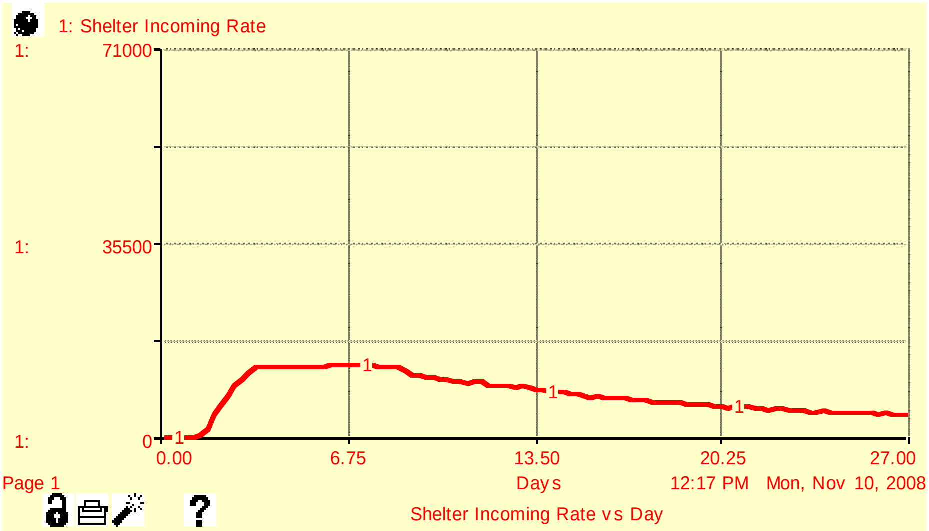


Figure 72. "Shelter Incoming Rate" for a Simulation Run with the Integration Time Step=0.25 days. Author's Elaboration, 2008.

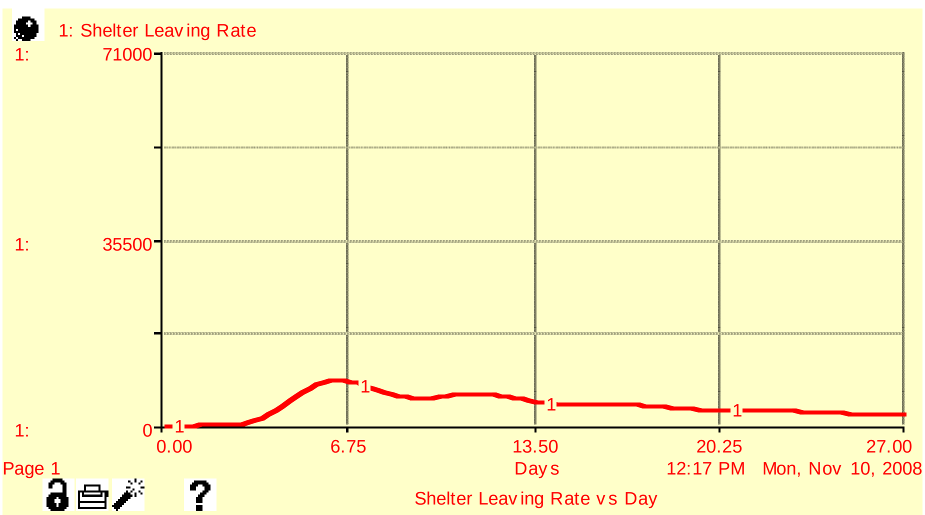


Figure 73. "Shelter Leaving Rate" for a Simulation Run with the Integration Time Step=0.25 days. Author's Elaboration, 2008.

The results exhibit that the model is not sensitive to the choice of the Integration Time Step for the simulation runs (see appendix H).

The magnitude of integration error depends on how quickly the rates change relative to the time step. Next the comparison between the simulated values of two variables in a specific period of time to the exact value of the real data provided by the reference modes for the values of dt specified above are presented (see Tables 16 and 17).

Table 16. “Shelter Incoming Rate”: Integration Error Depends on the Time Step. Author’s Elaboration, 2008.

Time Step (dt) (Days)	Simulated Shelter Incoming Rate at t=6 (People)	% Error (Exact Real Value=12,958)
0.1	12,900	0.45%
0.125	12,900	0.45%
0.25	13,200	-1.83%

The exact value of “Shelter Incoming Rate” after 6 days in the reference mode is 12,958 people. With a time step of 0.125 days, the simulation error is less than 1%, a low value of integration after 6 days.

Table 17. “Shelter Leaving Rate”: Integration Error Depends on the Time Step. Author’s Elaboration, 2008.

Time Step (dt) (Days)	Simulated Shelter Leaving Rate at t=13 (People)	% Error (Exact Real Value=4,854)
0.1	4,876	-0.46%
0.125	4,894	-0.81%
0.25	4,985	-2.62%

The exact value of “Shelter Leaving Rate” after 13 days in the reference mode is 4,854 people. With a time step of 0.125 days, the simulation error is less than 1%, a low value of integration after 13 days.

The magnitude of integration error depends on how quickly the rates change relative to the time step. The comparison between the simulated values of two variables in a specific period of time to the exact value of the real data provided by the reference modes for the values of dt specified shows that for small time steps, the errors are small. Increasing the time step increases the magnitude of the error. Therefore, the integration in Stella^{TM} is adequate for the model (see appendix H).

4.2 USING AND INTERPRETING THE MODEL

As shown in Figure 74, the model runs directly from a control panel designed for easy input of data for scenario creation for the decision-maker. On the left of the interface there is a brief explanation of the purpose of the model and the subsystems contained in it, and are labeled as “*About this model*” and the “*Sector Mapping of the SQRC*” respectively.

Each subsystem of this model has it own control panel. The user can vary the input values of the model variables represented in the control panel as sliders, switches and knobs.

The model's user can open the sliders by double-clicking within its border, or by selecting it and choosing "Open Selection" from the Interface menu. Each slider has Min and Max fields for setting the display range. The model's user can use the tab between these boxes to enter the range according to the time horizon of the relief operation for the end-user's variation.

The buttons on the bottom of each subsystem control panel control some actions within the simulation. The *run* button runs the model for 27 days each time it is pressed. Decisions and policies may be changed every 27 days, replicating user's decisions. The *pause* button pauses the simulation run. The stop button causes the simulation to cease its execution. The *reset* button is used when a new scenario needs to be simulated and returns all variables to their original values and clears the graphs.

Some buttons offer the user information about cautions and helpful hints to consider when a simulation is run. Those are: *caution*, *helpful hints* and *about reset* button.

The buttons below each subsystem's reference modes are labeled as *Go to "Katrina Behavior"* and *Go to "Rita Behavior"*, and move the user to the exact place where these reference modes are located inside the model.

Go to "Control Panel" buttons located inside sector mapping, moves the user to each subsystem control panel.

Above Client's Satisfaction time series graph there is a status indicator located. The status indicator is green if the client's satisfaction is over 70%.

Back buttons take the user back to specific parts of the interface or model. *Home buttons* take the user back to the home screen. Close button close the model clicking the x. The *Help button* gives instructions about the use of home buttons and close buttons.

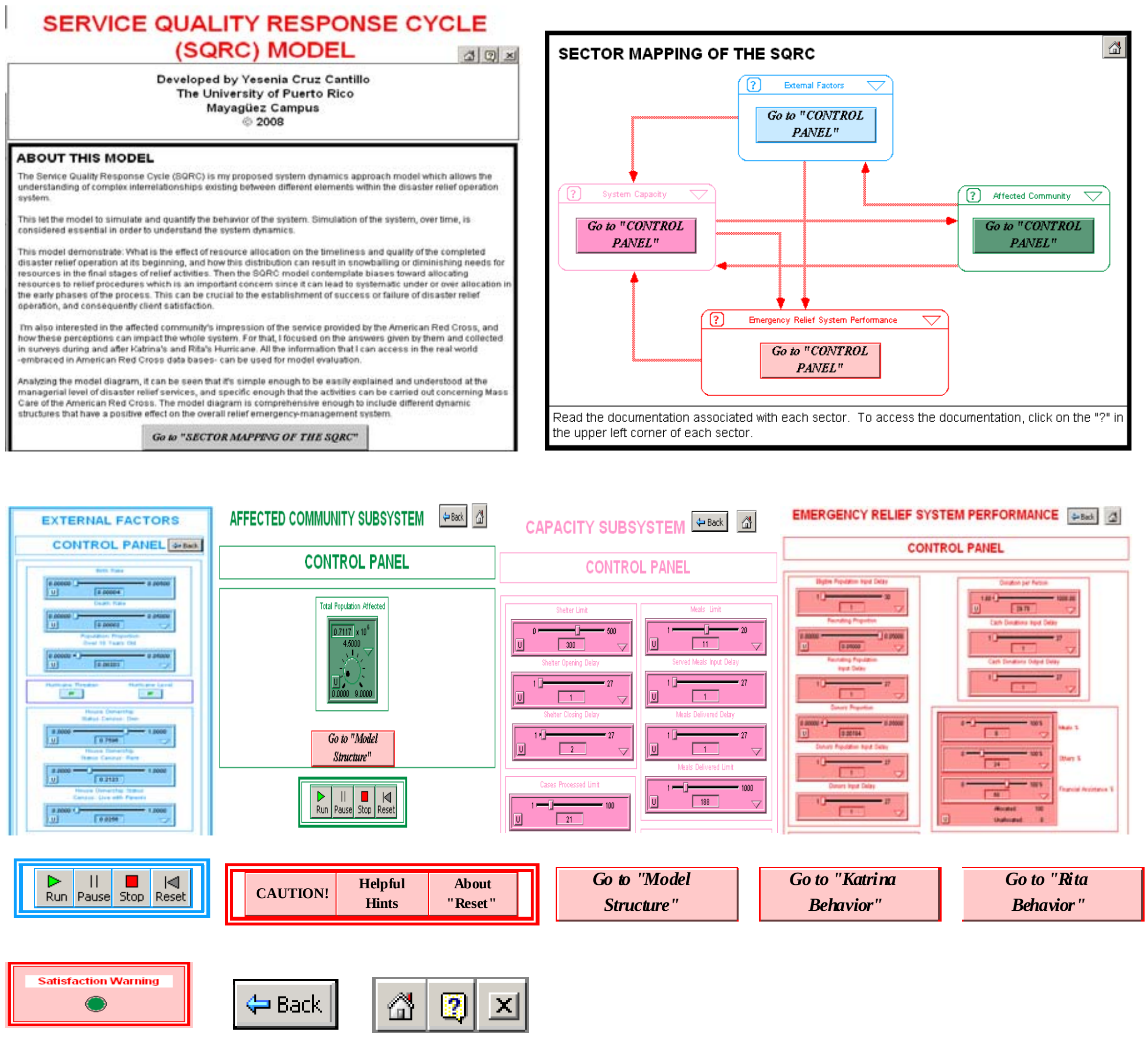


Figure 74. Control Panel SQRC Model. Author's Elaboration, 2008.

Finally, time series graphs are located in each subsystem control panel representing each key variable of the SQRC model.

4.3 KEY VARIABLES IN THE KATRINA OPERATION ESTIMATED BY "OTHER SOURCES" VS. SQRC MODEL RESULTS

Table 18 shows a comparison between Other Sources (previously exhibit in Table 9) and the SQRC simulation's results.

Table 18. Comparison Evacuated Population: "Other Sources" vs. SQRC Model. Author's Elaboration, 2008.

Population	Boyd et al. (2008)	FEMA (2007)	CRS (Congressional Research Services) (2005)	SQRC Model
Total Affected Population (LA, MS, AL)	NA	NA	711,698	**711,698**
Total Evacuated Population Before	1,000,000	NA	NA	**393,590**
Total Evacuated Population After	100,000	NA	NA	**13,465**
Total Evacuated Population During	100,000	NA	NA	**3,512**
Not Evacuated Population	130,000	NA	NA	**257,000**
People in Shelter	67,800	62,000	NA	**67,585**
Evacuated Population	780,353	1,040,000	NA	**667,567**
Not Sheltered	NA	NA	NA	**44,131**

The initial input value for "Total Population Affected" was set based in the value estimated by the CRS.

Discrepancies were found between sources. Boyd et al. estimated that 1,000,000 evacuated before the hurricane hits. To match Boyd et al. source the SQRC model must be initialized at least in 2.5 million of Total Population Affected to generate the values they estimated for evacuated population. For that reason Boyd et al. values don't match the SQRC model values.

With the comparison to reference modes test, it can be seen that the real data provided by ARC, follows a similar behavior with the simulated key variables. The quantities related to the key variables are in a similar range with the ARC data bases values. For the behavior of "People in Shelter", real data for other sources value range between 62,000 and 67,800 people; the SQRC model shows 67,585 people (see Figure 75 and Table 19).

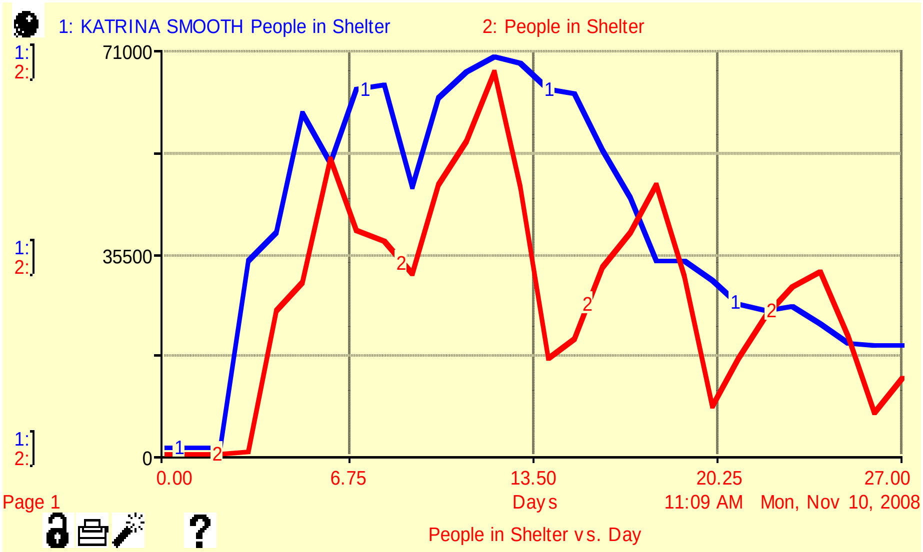


Figure 75. "People in Shelter": Real Data vs. Simulation. Author’s Elaboration, 2008.

Table 19. "People in Shelter": Real Data vs. Simulation. Author's Elaboration, 2008.

Days	KATRINA SMOOTH People in Shelter	People in Shelter
0	1315	10
1	1315	10
2	1315	10
3	34324	610
4	39197	25510
5	60098	30310
6	51482	52153
7	64440	39432
8	65155	37802
9	47371	31866
10	62878	47648
11	67521	55239
12	70227	67585
13	69270	47108
14	64416	17216
15	63696	20454
16	53772	33023
17	45267	39157
18	34433	47625
19	34141	31641
20	30662	8710
21	26592	16874
22	25622	24556
23	26029	29597
24	23045	32521
25	19665	20844
26	19520	7428
27	19287	13469

Therefore, although there are inconsistencies with the values estimates in literature the SQRC model behaves in an appropriate way compared with the data provided by the ARC. This is the primary source of data of this research work.

4.4 POLICY DESIGN AND EVALUATION

In this stage, structure and decision policies design helped to generate the observable patterns of behavior of the system, because testing alternatives and new policies can improve the dynamics of the model. To design alternative polices, and test them by simulation runs, some phases needed to be followed.

4.4.1 Scenario specification

Once the model was tested and was ready to be used, the model was run under the existing policies and practices to establish the status quo scenario.

4.4.1.1 Status Quo Scenario: Baseline

The baseline case was defined with the parameters and input values for the Katrina hurricane case (see appendix G).

Scenarios for Proving Hypothesis 1

For the purpose of demonstrating the validity of hypothesis 1 of this research work, SQRC Model was run using 88 scenarios:

- 66 scenarios were run with increases and reductions for each resource involved in the measurement of the client's satisfaction. That is, these scenarios were run for the variables related to the behavior of the following variables: served meal, delivered financial assistance and DSHR capacity.

- 22 scenarios were run with increases and reductions for the combined resources involved in the measurement of client's satisfaction. That is, these scenarios were run for the variables related to the behavior of the combination of the following key variables: served meal, delivered financial assistance and DSHR capacity.

4.4.1.2 Increment in Meals Scenario

In order to evaluate what would happen with the client's satisfaction if the available meals were increased dramatically; a simulation was run making increases of: 5%, 10%, 15%, 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the input values of specific variables related to the behavior of this resource. Variable changes can be seen in Table 20.

Table 20. Variables Changes Increments in Meals Scenario. Author's Elaboration, 2008.

		Variable Name		
		Meals Delivered Limit	Meals Stored	Meals%
	Base Case Value	188	1,000,000	8
Value with Increment	5%	197	1,050,000	8.4
	10%	207	1,100,000	8.8
	15%	216	1,150,000	9.2
	20%	226	1,200,000	9.6
	25%	235	1,250,000	10
	50%	282	1,500,000	12
	75%	329	1,750,000	14
	80%	338	1,800,000	14.4
	85%	348	1,850,000	14.8
	90%	357	1,900,000	15.2
	95%	367	1,950,000	15.6

4.4.1.3 Increment in Financial Assistance Scenario

In order to evaluate what would happen to the client's satisfaction if the financial assistance available was increased dramatically; a simulation was run making increases of: 5%, 10%, 15%, 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the input values of specific variables related to the behavior of this resource. Variables changes can be seen in Table 21.

Table 21. Variables Changes Increments in Financial Assistance Scenario. Author's Elaboration, 2008.

		Variable Name		
		Financial Assistance Limit	Financial Assistance %	Financial Assistance Fund
	Base Case Value	250	68	10,000
Value with Increment	5%	263	71	10,500
	10%	275	75	11,000
	15%	288	78	11,500
	20%	300	82	12,000
	25%	313	85	12,500
	50%	375	88	15,000
	75%	438	86	17,500
	80%	450	85.6	18,000
	85%	463	85.2	18,500
	90%	475	85	19,000
	95%	488	84	19,500

4.4.1.4 Increment in Mental Health Care Scenario

In order to evaluate what would happen to the client's satisfaction if the staff available was increased dramatically; a simulation was run making increases of: 5%, 10%, 15%, 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the input values of a specific variable related to the behavior of this resource. Variables changes can be seen in Table 22.

Table 22. Variables Changes Increments in Mental Health Care Scenario. Author's Elaboration, 2008.

		Variable Name
		Staff Availability Proportion
	Base Case Value	0.1
Value with Increment	5%	0.105
	10%	0.11
	15%	0.115
	20%	0.12
	25%	0.13
	50%	0.15
	75%	0.175
	80%	0.18
	85%	0.185
	90%	0.19
	95%	0.2

4.4.1.5 Reduction in Meals Scenario

In order to evaluate what would happen to the client's satisfaction if the meals available were reduced dramatically; a simulation was run making reductions of: 5%, 10%, 15%, 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the input values of specific variables related to the behavior of this resource. Variables changes can be seen in Table 23.

Table 23. Variables Changes Reductions in Meals Scenario. Author's Elaboration, 2008.

		Variable Name		
		Meals Delivered Limit	Meals Stored	Meals%
	Base Case Value	188	1,000,000	8
Value with Increment	5%	179	950,000	7.6
	10%	169	900,000	7.2
	15%	160	850,000	6.8
	20%	150	800,000	6.4
	25%	141	750,000	6
	50%	94	500,000	4
	75%	47	250,000	2
	80%	38	200,000	1.6
	85%	28	150,000	1.2
	90%	19	100,000	0.8
	95%	9	50,000	0.4

4.4.1.6 Reduction in Financial Assistance Scenario

In order to evaluate what would happen to the client's satisfaction if the financial assistance available was reduced dramatically; a simulation was run making reductions of: 5%, 10%, 15%, 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the input values of specific variables related to the behavior of this resource. Variables changes can be seen in Table 24.

Table 24. Variables Changes Reductions in Financial Assistance Scenario. Author's Elaboration, 2008.

		Variable Name		
		Financial Limit	Financial Assistance %	Financial Assistance Fund
	Base Case Value	250	68	10,000
Value with Increment	5%	238	65	9,500
	10%	225	61	9,000
	15%	213	58	8,500
	20%	200	54	8,000
	25%	188	51	7,500
	50%	125	34	5,000
	75%	63	17	2,500
	80%	50	14	2,000
	85%	38	10	1,500
	90%	25	7	1,000
	95%	13	3	500

4.4.1.7 Reduction in Mental Health Care Scenario

In order to evaluate what would happen to the client's satisfaction if the staff available was reduced dramatically; a simulation was run making reductions of: 5%, 10%, 15%, 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the input values of a specific variable related to the behavior of this resource. Variables changes can be seen in Table 25.

Table 25. Variables Changes Reductions in Mental Health Care Scenario. Author's Elaboration, 2008.

		Variable Name
		Staff Availability Proportion
	Base Case Value	0.1
Value with Increment	5%	0.095
	10%	0.09
	15%	0.085
	20%	0.08
	25%	0.075
	50%	0.05
	75%	0.03
	80%	0.02
	85%	0.015
	90%	0.01
	95%	0.005

4.4.1.8 Increment of 5% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 4.75. Including an increase of 5% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 26.

Table 26. Variables Changes Increment of 5% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 5%
DSHR Limit	51	54
Staff Availability Proportion	0.1	0.105
Meals Delivered Limit	188	197
Meals Stored	1,000,000	1,050,000
Meals%	8	8.4
Financial Limit	250	263
Financial Assistance %	68	71
Financial Assistance Fund	10,000	10,500

4.4.1.9 Increment of 10% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 4.5. Including an increase of 10% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 27.

Table 27. Variables Changes Increment of 10% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 10%
DSHR Limit	51	56
Staff Availability Proportion	0.1	0.110
Meals Delivered Limit	188	207
Meals Stored	1,000,000	1,100,000
Meals%	8	8.8
Financial Limit	250	275
Financial Assistance %	68	75
Financial Assistance Fund	10,000	11,000

4.4.1.10 Increment of 15% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 4.25. Including an increase of 15% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 28.

Table 28. Variables Changes Increment of 15% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 15%
DSHR Limit	51	59
Staff Availability Proportion	0.1	0.115
Meals Delivered Limit	188	216
Meals Stored	1,000,000	1,150,000
Meals%	8	9.2
Financial Limit	250	288
Financial Assistance %	68	78
Financial Assistance Fund	10,000	11,500

4.4.1.11 Increment of 20% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 4. Including an increase of 20% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 29.

Table 29. Variables Changes Increment of 20% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 20%
DSHR Limit	51	61
Staff Availability Proportion	0.1	0.120
Meals Delivered Limit	188	226
Meals Stored	1,000,000	1,200,000
Meals%	8	9.6
Financial Limit	250	300
Financial Assistance %	68	82
Financial Assistance Fund	10,000	12,000

4.4.1.12 Increment of 25% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 3.75. Including an increase of 25% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 30.

Table 30. Variables Changes Increment of 25% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 25%
DSHR Limit	51	64
Staff Availability Proportion	0.1	0.13
Meals Delivered Limit	188	235
Meals Stored	1,000,000	1,250,000
Meals%	8	10.0
Financial Limit	250	313
Financial Assistance %	68	85
Financial Assistance Fund	10,000	12,500

4.4.1.13 Increment of 50% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 2.5. Including an increase of 50% in the input values of specific variables related with to behavior of these resources. Variables changes can be seen in Table 31.

Table 31. Variables Changes Increment of 50% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 50%
DSHR Limit	51	77
Staff Availability Proportion	0.1	0.15
Meals Delivered Limit	188	282
Meals Stored	1,000,000	1,500,000
Meals%	8	12.0
Financial Limit	250	375
Financial Assistance %	68	88
Financial Assistance Fund	10,000	15,000

4.4.1.14 Increment of 75% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 1.25. Including an increase of 75% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 32.

Table 32. Variables Changes Increment of 75% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 75%
DSHR Limit	51	89
Staff Availability Proportion	0.1	0.175
Meals Delivered Limit	188	329
Meals Stored	1,000,000	1,750,000
Meals%	8	14.0
Financial Limit	250	438
Financial Assistance %	68	86
Financial Assistance Fund	10,000	17,500

4.4.1.15 Increment of 80% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 1. Including an increase of 80% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 33.

Table 33. Variables Changes Increment of 80% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 80%
DSHR Limit	51	92
Staff Availability Proportion	0.1	0.180
Meals Delivered Limit	188	338
Meals Stored	1,000,000	1,800,000
Meals%	8	14.4
Financial Limit	250	450
Financial Assistance %	68	85.60
Financial Assistance Fund	10,000	18,000

4.4.1.16 Increment of 85% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 0.75. Including an increase of 85% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 34.

Table 34. Variables Changes Increment of 85% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 85%
DSHR Limit	51	94
Staff Availability Proportion	0.1	0.185
Meals Delivered Limit	188	348
Meals Stored	1,000,000	1,850,000
Meals%	8	14.8
Financial Limit	250	463
Financial Assistance %	68	85.20
Financial Assistance Fund	10,000	18,500

4.4.1.17 Increment of 90% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 0.5. Including an increase of 90% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 35.

Table 35. Variables Changes Increment of 90% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 90%
DSHR Limit	51	97
Staff Availability Proportion	0.1	0.190
Meals Delivered Limit	188	357
Meals Stored	1,000,000	1,900,000
Meals%	8	15.2
Financial Limit	250	475
Financial Assistance %	68	85
Financial Assistance Fund	10,000	19,000

4.4.1.18 Increment of 95% in Combined Resources Scenario

In order to evaluate what would happen to the client's satisfaction if the resources (meals, financial assistance and DSHR capacity) available were increased dramatically; a simulation was run making a change in the delay for the training of the DSHR from 5 days to 0.25. Including an increase of 95% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 36.

Table 36. Variables Changes Increment of 95% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Increment of 95%
DSHR Limit	51	99
Staff Availability Proportion	0.1	0.20
Meals Delivered Limit	188	367
Meals Stored	1,000,000	1,950,000
Meals%	8	15.6
Financial Limit	250	488
Financial Assistance %	68	84
Financial Assistance Fund	10,000	19,500

4.4.1.19 Reduction of 5% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 5.25. Including a reduction of 5% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 37.

Table 37. Variables Changes Reduction of 5% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 5%
Staff Availability	0.1	0.095
Meals Delivered Limit	188	179
Meals Stored	1,000,000	950,000
Meals%	8	7.6
Financial Limit	250	238
Financial Assistance %	68	65
Financial Assistance Fund	10,000	9,500

4.4.1.20 Reduction of 10% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 5.5. Including a reduction of 10% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 38.

Table 38. Variables Changes Reduction of 10% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 10%
DSHR Limit	51	46
Staff Availability Proportion	0.1	0.090
Meals Delivered Limit	188	169
Meals Stored	1,000,000	900,000
Meals%	8	7.2
Financial Limit	250	225
Financial Assistance %	68	61
Financial Assistance Fund	10,000	9,000

4.4.1.21 Reduction of 15% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 5.75. Including a reduction of 15% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 39.

Table 39. Variables Changes Reduction of 15% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 15%
DSHR Limit	51	43
Staff Availability Proportion	0.1	0.085
Meals Delivered Limit	188	160
Meals Stored	1,000,000	850,000
Meals%	8	6.8
Financial Limit	250	213
Financial Assistance %	68	58
Financial Assistance Fund	10,000	8,500

4.4.1.22 Reduction of 20% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 6. Including a reduction of 20% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 40.

Table 40. Variables Changes Reduction of 20% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 20%
DSHR Limit	51	41
Staff Availability Proportion	0.1	0.080
Meals Delivered Limit	188	150
Meals Stored	1,000,000	800,000
Meals%	8	6.4
Financial Limit	250	200
Financial Assistance %	68	54
Financial Assistance Fund	10,000	8,000

4.4.1.23 Reduction of 25% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 6.25. Including a reduction of 25% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 41.

Table 41. Variables Changes Reduction of 25% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 25%
DSHR Limit	51	38
Staff Availability Proportion	0.1	0.075
Meals Delivered Limit	188	141
Meals Stored	1,000,000	750,000
Meals%	8	6.0
Financial Limit	250	188
Financial Assistance %	68	51
Financial Assistance Fund	10,000	7,500

4.4.1.24 Reduction of 50% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 7.5. Including a reduction of 50% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 42.

Table 42. Variables Changes Reduction of 50% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 50%
DSHR Limit	51	26
Staff Availability Proportion	0.1	0.05
Meals Delivered Limit	188	94
Meals Stored	1,000,000	500,000
Meals%	8	4
Financial Limit	250	125
Financial Assistance %	68	34
Financial Assistance Fund	10,000	5,000

4.4.1.25 Reduction of 75% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 8.75. Including a reduction of 75% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 43.

Table 43. Variables Changes Reduction of 75% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 75%
DSHR Limit	51	13
Staff Availability Proportion	0.1	0.03
Meals Delivered Limit	188	47
Meals Stored	1,000,000	250,000
Meals%	8	2.0
Financial Limit	250	63
Financial Assistance %	68	17
Financial Assistance Fund	10,000	2,500

4.4.1.26 Reduction of 80% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 9. Including a reduction of 80% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 44.

Table 44. Variables Changes Reduction of 80% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 80%
DSHR Limit	51	10
Staff Availability Proportion	0.1	0.020
Meals Delivered Limit	188	38
Meals Stored	1,000,000	200,000
Meals%	8	1.6
Financial Limit	250	50
Financial Assistance %	68	14
Financial Assistance Fund	10,000	2,000

4.4.1.27 Reduction of 85% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 9.25. Including a reduction of 85% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 45.

Table 45. Variables Changes Reduction of 85% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 85%
DSHR Limit	51	8
Staff Availability Proportion	0.1	0.015
Meals Delivered Limit	188	28
Meals Stored	1,000,000	150,000
Meals%	8	1.2
Financial Limit	250	38
Financial Assistance %	68	10
Financial Assistance Fund	10,000	1,500

4.4.1.28 Reduction of 90% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 9.5. Including a reduction of 90% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 46.

Table 46. Variables Changes Reduction of 90% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 90%
DSHR Limit	51	5
Staff Availability Proportion	0.1	0.01
Meals Delivered Limit	188	19
Meals Stored	1,000,000	100,000
Meals%	8	0.8
Financial Limit	250	25
Financial Assistance %	68	7
Financial Assistance Fund	10,000	1,000

4.4.1.29 Reduction of 95% in Combined Resources Scenario

The simulation was run under the opposite scenario, which is making a change in the delay for the training of the DSHR from 5 days to 9.75. Including a reduction of 95% in the input values of specific variables related to the behavior of these resources. Variables changes can be seen in Table 47.

Table 47. Variables Changes Reduction of 95% in Combined Resources Scenario. Author's Elaboration, 2008.

Variable Name	Base Case Value	Value with Reduction of 95%
DSHR Limit	51	3
Staff Availability Proportion	0.1	0.01
Meals Delivered Limit	188	9
Meals Stored	1,000,000	50,000
Meals%	8	0.4
Financial Limit	250	13
Financial Assistance %	68	3
Financial Assistance Fund	10,000	500

<u>Scenarios for Proving Hypothesis 2</u>

For the purpose of demonstrating the validity of hypothesis 2 of this research work, SQRC Model was run using 23 scenarios in order to demonstrate how these changes affect the level of satisfaction of the people in shelters:

- One scenario was run without DSHR.
- 22 scenarios were run with increases and reductions in the time for training of DSHR.

4.4.1.30 No DSHR Scenario

The simulation was run considering no DSHR is deployed to assist the relief operation. For that, staff availability proportion that controls de number of ARC staff available for a relief operation was set to zero. In the same way, the recruiting proportion that controls the structure that generates the number of potential people for recruiting was setting in zero.

4.4.1.31 Increment of 5% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the

"Trained Delay Duration" from 5 to 5.25 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.32 Increment of 10% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 5.5 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.33 Increment of 15% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 5.75 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.34 Increment of 20% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 6 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.35 Increment of 25% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 6.25 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.36 Increment of 50% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 7.5 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.37 Increment of 75% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the

"Trained Delay Duration" from 5 to 8.75 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.38 Increment of 80% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 9 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.39 Increment of 85% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 9.25 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.40 Increment of 90% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 9.5 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.41 Increment of 95% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. An increment in the "Trained Delay Duration" from 5 to 9.75 days was made to illustrate the impact of a deployment overdue in the client's satisfaction.

4.4.1.42 Reduction of 5% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the "Trained Delay Duration" from 5 to 4.75 days was made to illustrate the impact of speeding up deployment in the client's satisfaction.

4.4.1.43 Reduction of 10% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the

“Trained Delay Duration” from 5 to 4.5 days was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.44 Reduction of 15% in “Trained Delay Duration” Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the “Trained Delay Duration” from 5 to 4.25 days was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.45 Reduction of 20% in “Trained Delay Duration” Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the “Trained Delay Duration” from 5 to 4 days was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.46 Reduction of 25% in “Trained Delay Duration” Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the “Trained Delay Duration” from 5 to 3.75 days was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.47 Reduction of 50% in “Trained Delay Duration” Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the “Trained Delay Duration” from 5 to 2.5 days was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.48 Reduction of 75% in “Trained Delay Duration” Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the “Trained Delay Duration” from 5 to 1.25 days was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.49 Reduction of 80% in “Trained Delay Duration” Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the “Trained Delay Duration” from 5 to 1 day was made to illustrate the impact of speeding up deployment in the client’s satisfaction.

4.4.1.50 Reduction of 85% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the "Trained Delay Duration" from 5 to 0.75 day was made to illustrate the impact of speeding up deployment in the client's satisfaction.

4.4.1.51 Reduction of 90% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the "Trained Delay Duration" from 5 to 0.5 day was made to illustrate the impact of speeding up deployment in the client's satisfaction.

4.4.1.52 Reduction of 95% in "Trained Delay Duration" Scenario

The simulation was run to show the importance of the presence of DSHR in the distribution of assistance to the victims of a disaster. A reduction in the "Trained Delay Duration" from 5 to 0.25 day was made to illustrate the impact of speeding up deployment in the client's satisfaction.

Scenarios for Proving Hypothesis 3

For the purpose of demonstrating the validity of hypothesis 3 of this research work, SQRC Model was run using 1 scenario in order to demonstrate how these changes affect the disposition for evacuation:

4.4.1.53 Demographics and Profile Scenario

The simulation was run with a change in the proportion of non Hispanic white people whose income was more than $10,000 and less than $40,000 and who rent a property. The initial input value of 0.1520 was changed to 0.9.

4.4.2 Sensitivity Analysis and Policy Insights

Following the methodology, suggested by Sterman (2000), assessment of the robustness of the policy recommendations described above was performed, and their performance under different scenarios and different uncertainties were evaluated against the original dynamic hypothesis presented in chapter 3.

Hypothesis 1

An increment in the capabilities of the system and resources available (served meals, delivered financial assistance and DSHR capacity used during the recovery of the victims) would increase evacuated clients' perception of the quality of service provided at each stage of the relief operation. This satisfaction then will be greatly affected by the timeliness of the deployment of those resources.

- **Increments in Meals, Financial Assistance and Mental Health Care Scenarios**

The scenarios were run using several increments for each resource involved in the measurement of the client's satisfaction (served meals, delivered financial assistance and DSHR Capacity) tested separately shows that no change is produced in this key variable (see appendix I).

- **Reductions in Meals, Financial Assistance and Mental Health Care Scenarios**

The scenarios were run using several reductions for the resource variables related with the provision of financial assistance specified before shows that no change is produced in client's satisfaction (see appendix I).

The scenarios were run using several reductions for the variable related with the provision of Mental Health Care specified before, shows that no change is produced in client's satisfaction (see appendix I).

A variance of minus 50%, 75%, 80%, 85%, 90% and 95% for the resource variables related with the provision of meals specified before was made in order to demonstrate that a reduction in the provision of meals decreases the perception of the quality of service provided to the evacuated clients. It can be seen, in yellow marks, the reduction in the client's satisfaction for the 7^{th}, 8^{th}, 9^{th}, 13^{th}, 14^{th}, 19^{th}, 20^{th}, 25^{th} and 26^{th} day. Therefore, reduction in the provision of meals began to be critical above 50% (see Figure 76 and Table 48).

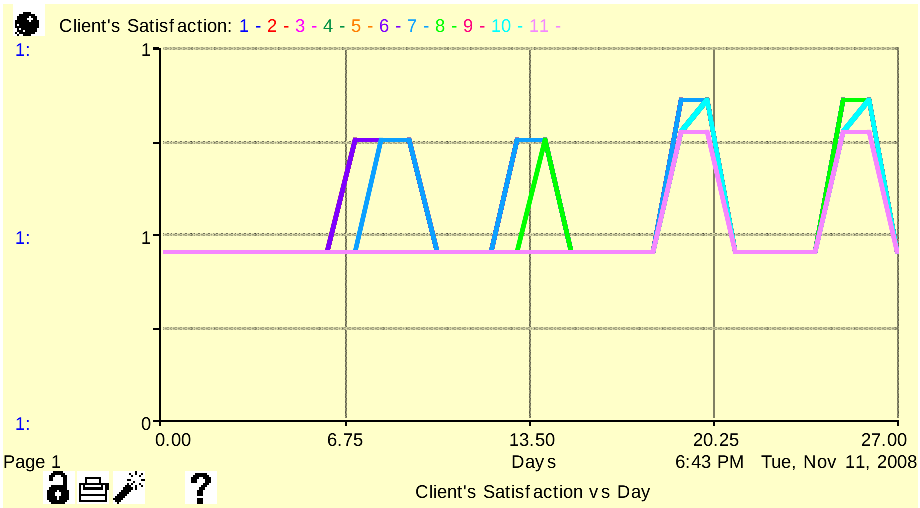


Figure 76. "Client's Satisfaction": Reductions in Meals Scenario. Author's Elaboration, 2008.

In this table "Client's Satisfaction" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results for the reductions specified above.

Table 48. "Client's Satisfaction": Reductions in Meals Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Meals Scenario										
		Value with Reduction of 5%	Value with Reduction of 10%	Value with Reduction of 15%	Value with Reduction of 20%	Value with Reduction of 25%	Value with Reduction of 50%	Value with Reduction of 75%	Value with Reduction of 80%	Value with Reduction of 85%	Value with Reduction of 90%	Value with Reduction of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798	0.7798	0.7798	0.7798	0.7798
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798	0.7798	0.7798
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12

This shows that in order to maintain an acceptable level of satisfaction between the evacuated clients, the ARC could reduce the provision of financial assistance and mental health care in any proportion and then the level of satisfaction would remain in the rank of the original values. However, reducing the provision of meals to the affected people causes a reduction in the level of satisfaction when this decrease is executed above the 50% of the original values.

Therefore, this scenario shows how the importance of meals' provision to the affected people in a relief operation leads to a drastic reduction in the client's satisfaction levels.

- **Increments in Combined Resources Scenarios**

The scenarios were run using several increments for the combined variables involved in the measurement of client's satisfaction which resulted in increments in the perception of the quality of service provided to the evacuated clients.

It can be seen, in yellow marks, the increment in the client's satisfaction for the 19th, 20th, 25th and 26th day. Therefore, the results demonstrate that the hypothesis that an increment in the capabilities of the system and resources available increases the perception of the quality of service provided to the evacuated clients only by the end of the relief operation and that even though the increase is minimum (approximately 4% over the actual parameters of the model) (see Figure 77 and Table 49).

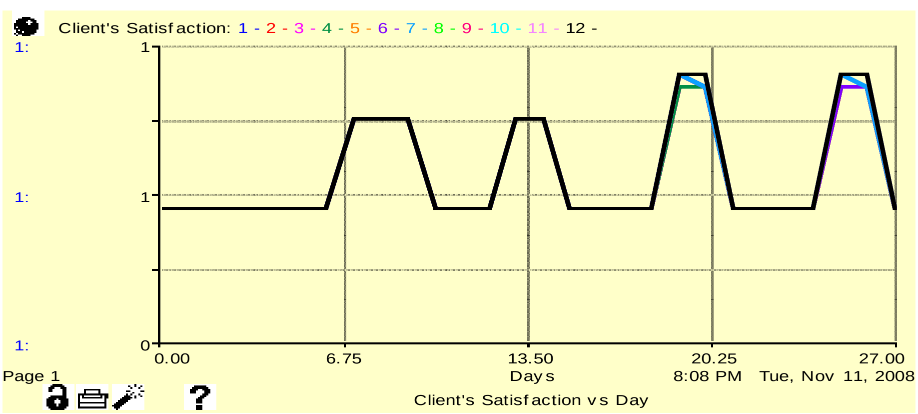


Figure 77. "Client's Satisfaction": Increments in Combined Resources Scenario. Author's Elaboration, 2008.

In this table "Client's Satisfaction" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results for the reductions specified above.

Table 49. "Client's Satisfaction": Increments in Combined Resources Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Combined Resources Scenario										
		Value with Increment of 5%	Value with Increment of 10%	Value with Increment of 15%	Value with Increment of 20%	Value with Increment of 25%	Value with Increment of 50%	Value with Increment of 75%	Value with Increment of 80%	Value with Increment of 85%	Value with Increment of 90%	Value with Increment of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12

This shows that the ARC would need to increase the provision of meals, financial assistance and mental health care in a 75% and reduce, in the same proportion, the training time of its personnel to reach a level of satisfaction of 90.81% for the evacuated people. However, this would be a too high increment to achieve his goal.

Therefore, this scenario shows that the level of satisfaction that the ARC would need in order to increase the client's satisfaction levels is not cost-effective for the organization.

- **Reductions in Combined Resources Scenarios**

A variance of minus 50%, 75%, 80%, 85%, 90% and 95% for the combined variables involved in the measurement of the client's satisfaction in order to demonstrate that a reduction in the capabilities of the system and resources available in combination decreases the perception of the quality of service provided to the evacuated clients. It can be seen, in yellow marks, the reduction in the client's satisfaction for the 7^{th}, 8^{th}, 9^{th}, 13^{th}, 14^{th}, 19^{th}, 20^{th}, 25^{th} and 26^{th}

day. Therefore, reduction in the provision of meals began to be critical above 20% (see Figure 78 and Table 50).

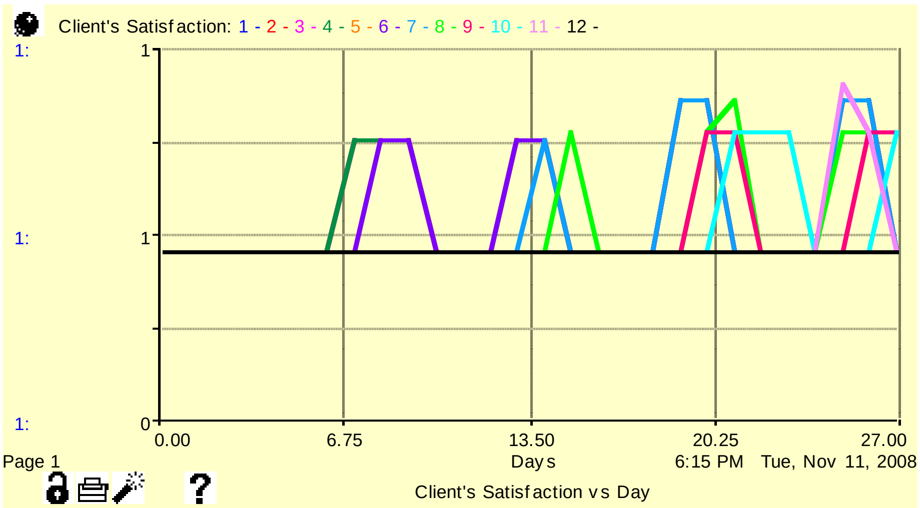


Figure 78. "Client's Satisfaction": Reductions in Combined Resources Scenario. Author's Elaboration, 2008.

In this table "Client's Satisfaction" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results for the reductions specified above.

Table 50. "Client's Satisfaction": Reductions in Combined Resources Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Combined Resources Scenario										
		Value with Reduction of 5%	Value with Reduction of 10%	Value with Reduction of 15%	Value with Reduction of 20%	Value with Reduction of 25%	Value with Reduction of 50%	Value with Reduction of 75%	Value with Reduction of 80%	Value with Reduction of 85%	Value with Reduction of 90%	Value with Reduction of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.7798	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.4545	0.4545	0.4545	0.4545	0.4545
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798	0.7798	0.4545	0.4545	0.4545
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.8658	0.7798	0.7798	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.7798	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.7798	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798	0.4545	0.4545	0.9081	0.4545
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.7798	0.7798	0.4545	0.7798	0.4545
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.7798	0.7798	0.7798	0.4545	0.4545
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12

This shows that in order to maintain an acceptable level of satisfaction for the evacuated clients, the ARC could reduce the provision of meals, financial assistance and mental health care below a 20%. However, reducing the provision of these resources above this value cause a consider reduction in the level of satisfaction.

Hypothesis 2

The level of satisfaction of the people in shelters with the rate of reporting and opening of cases during and after the event depends on the amount of DSHR deployed for this response operation.

- **No DSHR Scenario**

The simulation was run without DSHR, which shows how the provision of meals, financial assistance, the processing of cases and the client's satisfaction is severely affected (see Figure 79 and Table 51).

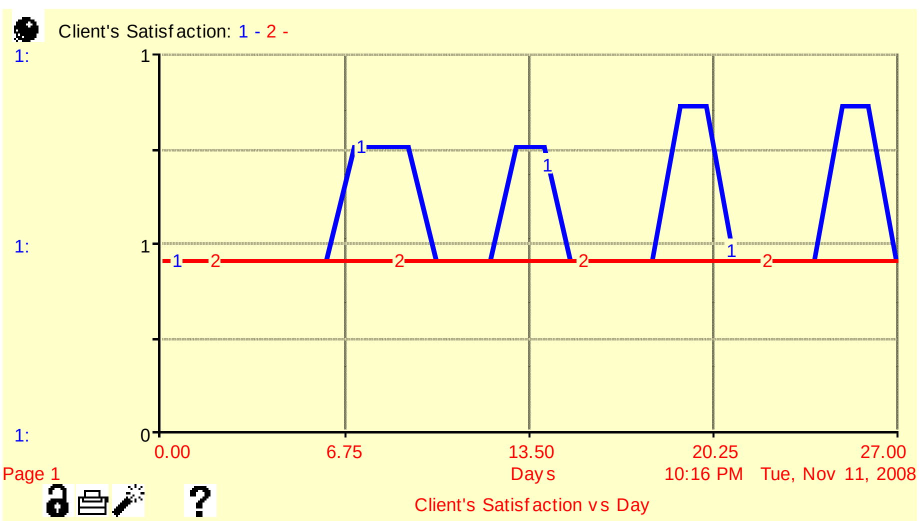


Figure 79. "Client's Satisfaction": No DSHR Scenario. Author's Elaboration, 2008.

In this table "Client's Satisfaction" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results obtained from the No DSHR Scenario.

Table 51. "Client's Satisfaction", "Served Meals", "Opened Cases", "Delivered Financial Assistance": No DSHR Scenario. Author's Elaboration, 2008.

Days	Baseline				No DSHR Scenario			
	Client's Satisfaction	Served Meals	Opened Cases	Delivered Financial Assistance	Client's Satisfaction	Served Meals	Opened Cases	Delivered Financial Assistance
0	0.4545	0	0	0	0.4545	0	0	0
1	0.4545	0	0	0	0.4545	0	0	0
2	0.4545	0	0	0	0.4545	0	0	0
3	0.4545	0	0	0	0.4545	0	0	0
4	0.4545	3760	0	10000	0.4545	0	0	0
5	0.4545	167132	179	10000	0.4545	0	0	0
6	0.4545	333410	7650	31222	0.4545	0	0	0
7	0.7586	573677	15035	97036	0.4545	0	0	0
8	0.7586	433754	20070	231013	0.4545	0	0	0
9	0.7586	415823	13092	456744	0.4545	0	0	0
10	0.4545	350526	1829	797842	0.4545	0	0	0
11	0.4545	524128	0	1277878	0.4545	0	0	0
12	0.4545	607629	12575	1920484	0.4545	0	0	0
13	0.7586	743429	26602	2749232	0.4545	0	0	0
14	0.7586	518185	29210	3787734	0.4545	0	0	0
15	0.4545	189374	11308	4303969	0.4545	0	0	0
16	0.4545	224993	0	5113484	0.4545	0	0	0
17	0.4545	363252	0	8255742	0.4545	0	0	0
18	0.4545	430732	10184	9789371	0.4545	0	0	0
19	0.8658	523872	19903	11906185	0.4545	0	0	0
20	0.8658	348049	20214	7910217	0.4545	0	0	0
21	0.4545	95814	6050	2177608	0.4545	0	0	0
22	0.4545	185616	0	4218554	0.4545	0	0	0
23	0.4545	270117	1148	6139027	0.4545	0	0	0
24	0.4545	325567	8168	7399263	0.4545	0	0	0
25	0.8658	357731	14282	8130256	0.4545	0	0	0
26	0.8658	229284	13159	5211003	0.4545	0	0	0
27	0.4545	81702	2686	1856876	0.4545	0	0	0

Running the model without DSHR shows that the number of served meals, opened cases and delivered financial assistance turn into 0. The client's satisfaction reaches the lowest value possible, 45.45% which happens when no meals, no financial assistance and no mental health care is provided as a result of No DSHR availability.

The lowest possible value that client's satisfaction could reach is 45.45%, this is a result of the likelihood obtained by CHAID analysis in the establishment of client's good perceptions. This value comes as a result of the comparison between the resources required and the resources served during the relief operation. Therefore, 45.45% is the client's satisfaction level achieved when no financial assistance and food are provided.

Therefore, the results demonstrate that the hypothesis that the amount of DSHR deployed impact the level of satisfaction due to the effectiveness of services provided to the people in shelters and the rate of reporting and opening of cases.

- **Relationship with DSHR Training Efficacy**

Other scenarios were tested making increments and reductions in the "Trained Delay Duration" in order to illustrate the impact that a delayed and overdue deployment would have on the client's satisfaction.

<u>Increments in "Trained Delay Duration"</u>

The scenarios were run using several increments in the "Trained Delay Duration" (see Figure 80 and Table 52).

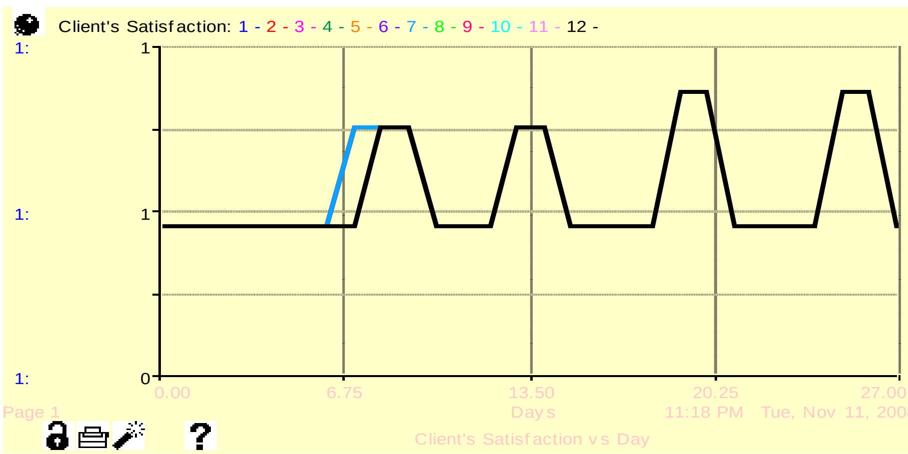


Figure 80. "Client's Satisfaction": Increments in "Trained Delay Duration" Scenario. Author's Elaboration, 2008.

In this table "Client's Satisfaction" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results obtained from the Increments in "Trained Delay Duration" Scenario.

Table 52. "Client's Satisfaction": Increments in “Trained Delay Duration” Scenario. Author’s Elaboration, 2008.

Days	Baseline Scenario	Trained Delay Duration Scenario										
		Value with Increment of 5%	Value with Increment of 10%	Value with Increment of 15%	Value with Increment of 20%	Value with Increment of 25%	Value with Increment of 50%	Value with Increment of 75%	Value with Increment of 80%	Value with Increment of 85%	Value with Increment of 90%	Value with Increment of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.4545	0.4545	0.4545	0.4545	0.4545
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545

It can be seen, in yellow marks, the reduction in the client’s satisfaction just occurs for the 7th day. Increments in the training time began to be critical above 75%.

Reductions in “Trained Delay Duration”

A variance of minus 20%, 25%, 50%, 75%, 80%, 85%, 90% and 95% in the “Trained Delay Duration” was made in order to demonstrate that a reduction in the time for training of the DSHR increases the perception of the quality of service provided to the evacuated clients. It can be seen in yellow marks, the increasing in the client’s satisfaction for the 19th, 20th, 25th and 26th day. Therefore, reduction in the training time began to be critical above 20% (see Figure 81 and Table 53).

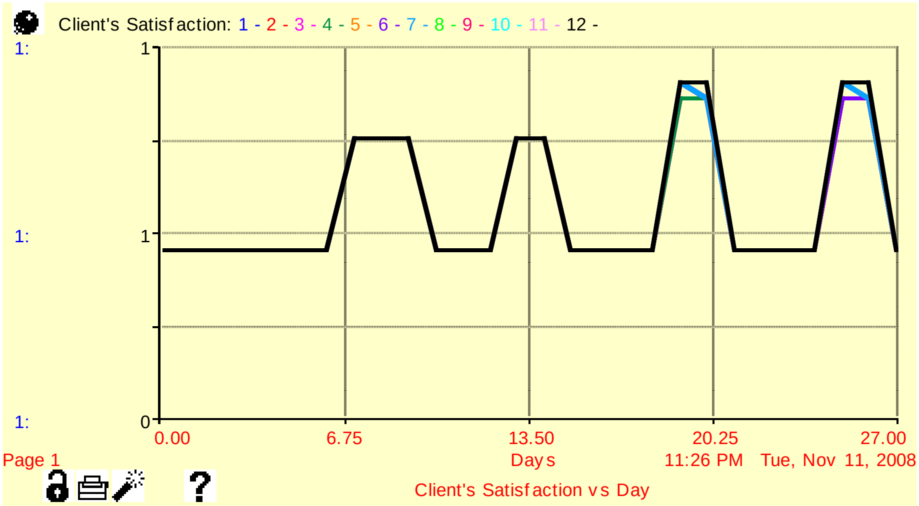


Figure 81. "Client's Satisfaction": Reductions in Trained Delay Scenario. Author's Elaboration, 2008.

In this table "Client's Satisfaction" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results obtained from the reductions in "Trained Delay Duration" Scenario.

Table 53. "Client's Satisfaction": Reductions in Trained Delay Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Trained Delay Duration Scenario										
		Value with Reduction of 5%	Value with Reduction of 10%	Value with Reduction of 15%	Value with Reduction of 20%	Value with Reduction of 25%	Value with Reduction of 50%	Value with Reduction of 75%	Value with Reduction of 80%	Value with Reduction of 85%	Value with Reduction of 90%	Value with Reduction of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081	0.9081
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.9081	0.9081	0.9081	0.9081	0.9081
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545

This shows that in order to maintain an acceptable level of satisfaction for the evacuated clients, the ARC could reduce the training time above a 20%.

Therefore, the results demonstrate that the hypothesis that the amount of DSHR deployed impact the level of attention provided to the people in shelters and the rate of reporting and opening of cases for a relief operation, is shown for the actual structure of the model.

Hypothesis 3

The disposition for evacuation that clients had, at this point in the hurricane event, depend on their demographic characteristics and profile, and in turn, the number of people that evacuated. A sudden increase in the number of people that go to the shelters will require larger numbers of trained staff and volunteers need to be ready for deployment in anticipation.

The simulation was run changing the proportion of non Hispanic white people with income more than $10,000 and less than $40,000. The initial input value of 0.1520 was changed to 0.9 (see Figure 82 and Table 54).

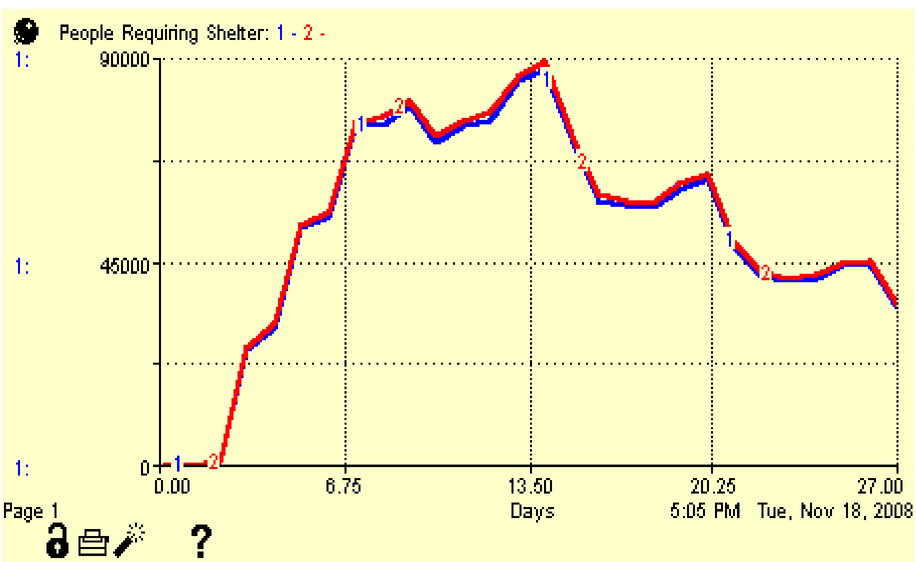


Figure 82. "People Requiring Shelter": Demographics and Profile Scenario. Author's Elaboration, 2008.

In this table Evacuated Population Before, After, During and Not Evacuated in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results obtained from the Demographics and Profile Scenario.

Table 54. "People requiring Shelter": Demographics and Profile Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario					Demographics and Profile Scenario				
	Total Evacuated Population Before Hurricane	Total Evacuated Population After Hurricane	Total Evacuated Population During Hurricane	Total Not Evacuated Population	People Requiring Shelter	Total Evacuated Population Before Hurricane	Total Evacuated Population After Hurricane	Total Evacuated Population During Hurricane	Total Not Evacuated Population	People Requiring Shelter
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	116,004	0	0	0	0	117,747	0
2	393,590	0	0	210,724	612	401,496	0	0	213,962	622
3	369,139	13,465	0	224,431	25,576	376,554	13,508	0	227,841	26,093
4	346,207	7,677	2,332	233,414	30,580	353,161	7,701	2,362	236,955	31,296
5	324,699	4,377	3,294	240,289	52,729	331,221	4,391	3,337	243,935	53,317
6	304,528	2,496	3,512	245,504	55,135	310,644	2,504	3,559	249,232	56,471
7	285,610	1,423	3,350	249,405	75,392	291,346	1,428	3,397	253,197	76,248
8	267,867	812	3,016	252,263	75,669	273,247	815	3,060	256,104	77,522
9	251,226	463	2,624	254,292	79,867	256,272	465	2,662	258,169	80,893
10	235,619	264	2,233	255,660	71,638	240,352	266	2,267	259,564	73,312
11	220,982	151	1,873	256,500	75,708	225,421	152	1,903	260,422	76,512
12	207,254	87	1,556	256,918	76,584	211,417	87	1,582	260,850	78,597
13	194,379	50	1,284	257,000	85,459	198,283	50	1,307	260,936	86,562
14	182,304	29	1,056	256,811	88,013	185,965	29	1,077	260,748	89,987
15	170,979	17	866	256,406	72,018	174,412	17	884	260,339	73,049
16	160,357	10	709	255,826	58,837	163,577	10	723	259,752	60,109
17	150,395	6	581	255,109	57,829	153,415	6	593	259,024	58,728
18	141,052	4	476	254,281	57,047	143,885	4	486	258,183	58,158
19	132,290	3	391	253,364	61,337	134,947	3	399	257,252	62,649
20	124,072	2	319	252,377	63,545	126,564	2	327	256,247	64,746
21	116,365	2	262	251,332	48,709	118,702	2	269	255,186	49,787
22	109,136	2	217	250,243	41,766	111,328	2	224	254,078	42,712
23	102,356	2	180	249,119	40,951	104,412	2	185	252,934	41,457
24	95,998	2	149	247,967	41,494	97,926	2	153	251,763	42,450
25	90,035	2	124	246,794	44,324	91,843	2	128	250,570	44,821
26	84,442	2	103	245,603	44,368	86,138	2	107	249,361	45,597
27	79,197	2	87	244,402	34,749	80,787	2	91	248,140	35,505

Table 55, shows that with a change in the proportion of non Hispanic white people whose income was more than $10,000 and less than $40,000 and who rent a property, results in an increase in the of people that evacuated and required shelter. It means that if a person is a property renter and the higher the income the more likely it is that person will evacuate. Therefore, the results demonstrate that the hypothesis that the amount of people that evacuated depended on their demographic characteristics and profile as shown for the actual structure of the model.

Results in Tables 54 and 55 demonstrate that an increase in the proportion of people with certain demographics characteristics and profile increment in the number of people that are requiring shelters and in turn increase the numbers of trained staff and volunteers that need to be ready for deployment in anticipation. (see Figure 83).

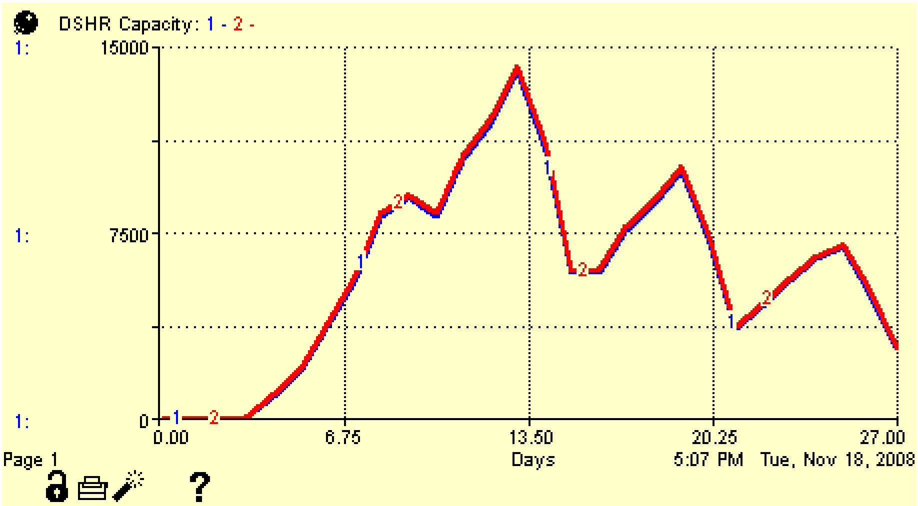


Figure 83. "DSHR Capacity": Demographics and Profile Scenario. Author's Elaboration, 2008.

In this table "DSHR Capacity" in the Status Quo Scenario (Baseline) is compared to the SQRC simulation results obtained from the Demographics and Profile Scenario.

Table 55. "DSHR Capacity": Demographics and Profile Scenario. Author's Elaboration, 2008.

Days	DSHR Capacity	
	Baseline Scenario	Demographics and Profile Scenario
0	0	0
1	0	0
2	0	0
3	20	21
4	889	908
5	1,928	1,972
6	3,720	3,784
7	5,594	5,704
8	8,157	8,296
9	8,999	9,085
10	8,133	8,335
11	10,536	10,679
12	11,965	12,268
13	14,093	14,277
14	10,914	11,199
15	5,919	5,945
16	5,926	6,070
17	7,614	7,740
18	8,623	8,824
19	10,036	10,238
20	7,464	7,625
21	3,641	3,732
22	4,525	4,577
23	5,595	5,651
24	6,424	6,546
25	6,939	7,057
26	5,051	5,248
27	2,771	2,782

4.5 MODEL VERIFICATION

The model was verified to be accepted and used to support decision making. With verification, it was ensured that the model program was correct and did not contain logical errors; the specification was completed and mistakes were not made in implementing the model (Macal, 2005).

4.6 MODEL VALIDATION WITH A DIFFERENT HURRICANE EVENT

Validation ensures, it ensured that the model meets its intended requirements in terms of the method utilized. The results achieved provided precise information about the modeled system (Macal, 2005).

This step involves the testing of the model as to whether it replicates the behavior of the real-world system. This model was validated with the data provided by the American Red Cross **Rita Hurricane** disaster.

The time horizon of this relief operation was 17 days long. Rita struck on 24 September, 2005 between Sabine Pass, Texas and Johnsons Bayou, Louisiana, as a Category 3 hurricane on the Saffir-Simpson Hurricane Scale. The affected areas were: Arkansas, South Florida, Florida Panhandle, Louisiana, Mississippi and Texas (Wikipedia).

Simulation Control Parameters

- Length of Simulation: From 0 to 17 days. This time horizon corresponds to the duration of the Rita Hurricane Operation and would correspond to a large disaster operation.

- Interval of Time between calculations: DT = 1.0 day.

User Defined Parameters

Initial values used in this model and the source that provided the information are specified in Tables 56 and 57.

Table 56. User Defined Parameters: Rita Relief Operation. Author's Elaboration, 2008.

Component of SQRC	Variable Name	Initial Value	Source
External Factors	Birth Rate	0.00004	Central Intelligence Agency.
	Death Rate	0.00002	Central Intelligence Agency.
	Population Proportion Over 18 Years Old	0.00203	Central Intelligence Agency.
	Hurricane Threaten	ON=1	Defined by the Programmer.
	Hurricane Level	ON=1	Defined by the Programmer.
	House Ownership Status Census: Own	0.7596	United States Census Bureau.
	House Ownership Status Census: Rent	0.2123	United States Census Bureau.
	House Ownership Status Census: Live with Parents	0.0256	United States Census Bureau.
	Household Income Census: Less Than 10K and Own	0.0950	United States Census Bureau.
	Household Income Census: Less Than 10K and Rent	0.7620	United States Census Bureau.
	Household Income Census: More Than 10K Less Than 40K and Rent	0.1460	United States Census Bureau.
	Race Non Hispanic White Income More Than 10K Less Than 40K Renter	0.1520	United States Census Bureau.
	Good News Spread Rate	0.70	Defined by the Programmer.
	Bad News Spread Rate	0.80	Defined by the Programmer.
Affected Community	Total Population Affected (LA, MS, TX)	711,698	CRS (Congressional Research Services).
	People in Shelter	10	Defined by the Programmer.
System Capacity	Shelter Limit	300	American Red Cross.
	Shelter Opening Delay	1	Disaster Operation Summary Reports.
	Shelter Closing Delay	1	Disaster Operation Summary Reports.
	Meals Limit	6	American Red Cross.
	Served Meals Input Delay	1	Defined by the Programmer.
	Meals Delivered Delay	1	Defined by the Programmer.
	Meals Delivered Limit	138	American Red Cross.
	Cases processed Limit	9	American Red Cross.
	Number of Family Group' People per Case	4	United States Census Bureau.
	Cases Opening Delay	1	Disaster Operation Summary Reports.

Table 57. User Defined Parameters: Rita Relief Operation. Author's Elaboration, 2008 (Continued).

Component of SQRC	Variable Name	Initial Value	Source
System Capacity	Cases Closing Delay	1	**Disaster Operation Summary Reports.**
	Financial Assistance Limit	250	**American Red Cross.**
	Financial Assistance Required Input Delay	1	**Defined by the Programmer.**
	Financial Deployed Delay	1	**Defined by the Programmer.**
	ARC Staff	30,000	**American Red Cross.**
	Staff Availability Proportion	0.1	**American Red Cross.**
	Staff Deploying Delay	1	**Disaster Operation Summary Reports.**
	New Volunteers Input Delay	1	**Defined by the Programmer.**
	Volunteer Incoming Delay	1	**Defined by the Programmer.**
	Trained Delay Duration	5	**American Red Cross.**
	DSHR Limit	51	**American Red Cross.**
	DSHR Deploying Delay	1	**Disaster Operation Summary Reports.**
Emergency Relief System Performance	Eligible Population Input Delay	1	**Defined by the Programmer.**
	Recruiting Proportion	0.00002	**American Red Cross.**
	Recruiting Population Input Delay	1	**Defined by the Programmer.**
	Donors Proportion	0.00194	**American Red Cross.**
	Donors Population Input Delay	1	**Defined by the Programmer.**
	Donors Input Delay	1	**Defined by the Programmer.**
	Donation per Person	29.78	**American Red Cross.**
	Cash Donations Input Delay	1	**Defined by the Programmer.**
	Cash Donations Output Delay	1	**Defined by the Programmer.**
	Meals %	8	**American Red Cross.**
	Financial Assistance %	68	**American Red Cross.**
	Others %	24	**American Red Cross.**
	Meals Stored	1,000,000	**American Red Cross.**
	Price per Meal	5	**American Red Cross.**
	Meals Purchased Input Delay	1	**Defined by the Programmer.**
	Meals Purchased Output Delay	1	**Defined by the Programmer.**
	Financial Assistance Funds	10,000	**American Red Cross.**
	Financial Assistance Input Delay	**1**	**Defined by the Programmer.**

Figure 84, Figure 85, Figure 86, Figure 87, Figure 88, Figure 89 and Figure 90 show the comparison between real data and simulated data for the model runs. Again, the blue line represents the behavior of each key variable during relief operation of Rita hurricane and the red line represents the results of the model simulation.

The X-axis has the time of the simulation in days. The Y-axis represents the value of the key variable both simulated and real at each time.

Graphs for key variables suggest an acceptable behavior between the simulation and real data. Both graphics follow a similar pattern of behavior. Data points of the simulation remain in a similar range in comparison to the real data.

Because of the enormous fluctuations presented by the real data reported by the ARC, a smoothing method was applied with the objective of diminishing the noise of the data set. A smoothing procedure will change (soften) the fluctuations to represent a smooth curve instead that follow the trends of the behavior (see appendix J).

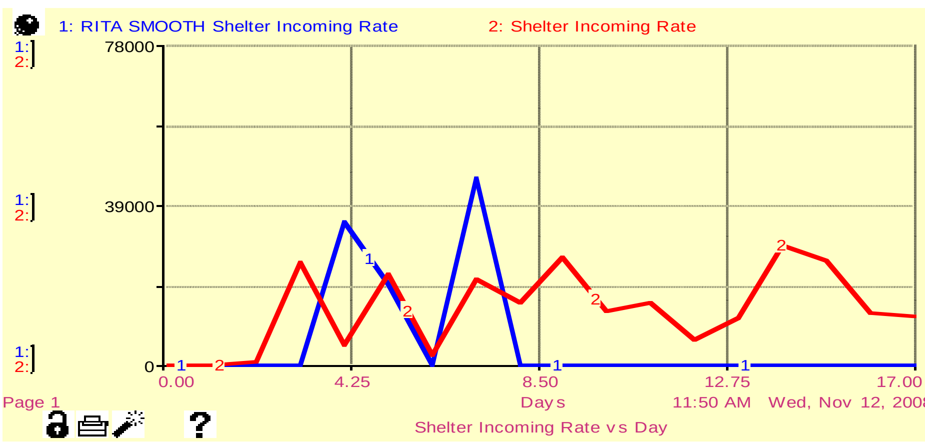


Figure 84. "Shelter Incoming Rate": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

The real data for "Shelter Incoming Rate" ranged from 0 to nearly 45,931 people. The simulation shows data ranged from 0 to 29,100 people.

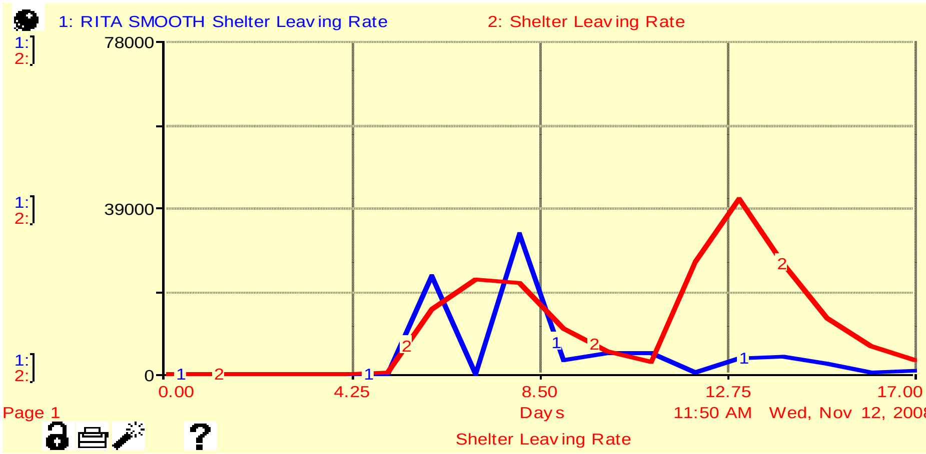


Figure 85. "Shelter Leaving Rate": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

The real data for "Shelter Leaving Rate" ranged from 0 to nearly 33,100 people. The simulation shows data ranged from 0 to 41,292 people.

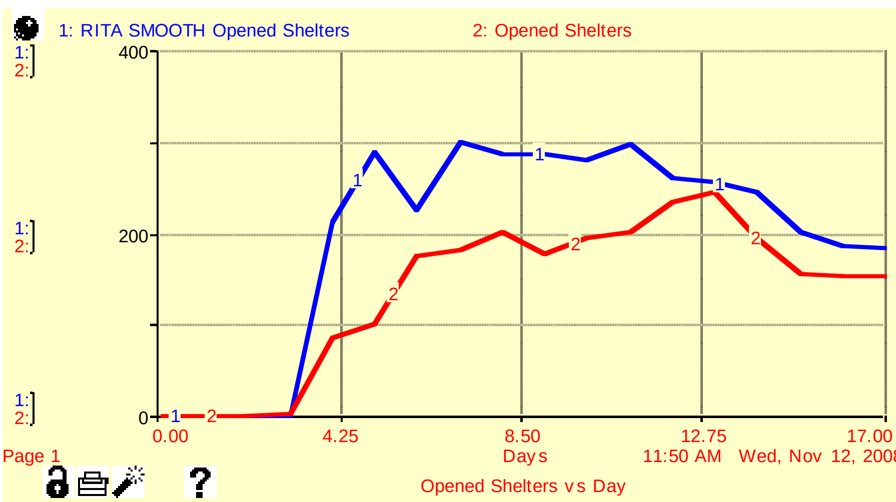


Figure 86. "Opened Shelters": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

In real data "Opened Shelters" ranged from 0 to nearly 301 units. Simulation shows data ranged from 0 to 246 units.

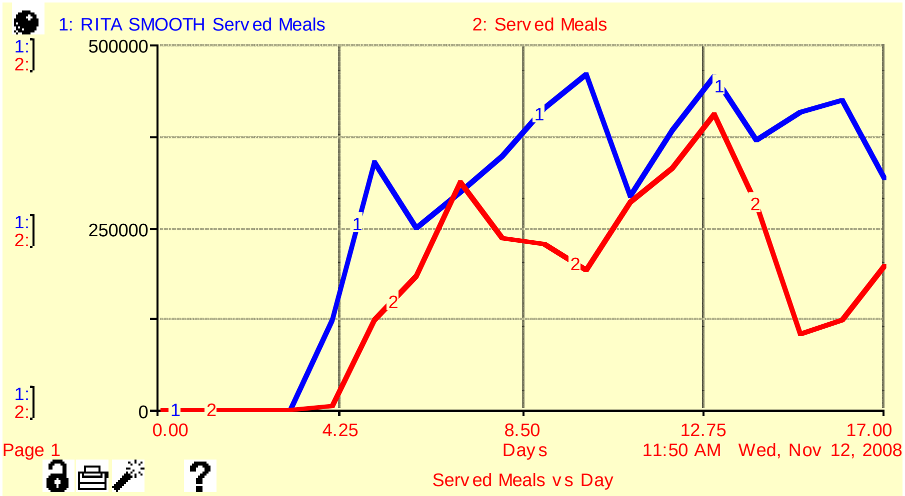


Figure 87. "Served Meals": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

In real data "Served Meals" ranged from 0 to nearly 461,599 units. Simulation shows data ranged from 0 to 405,507 units.

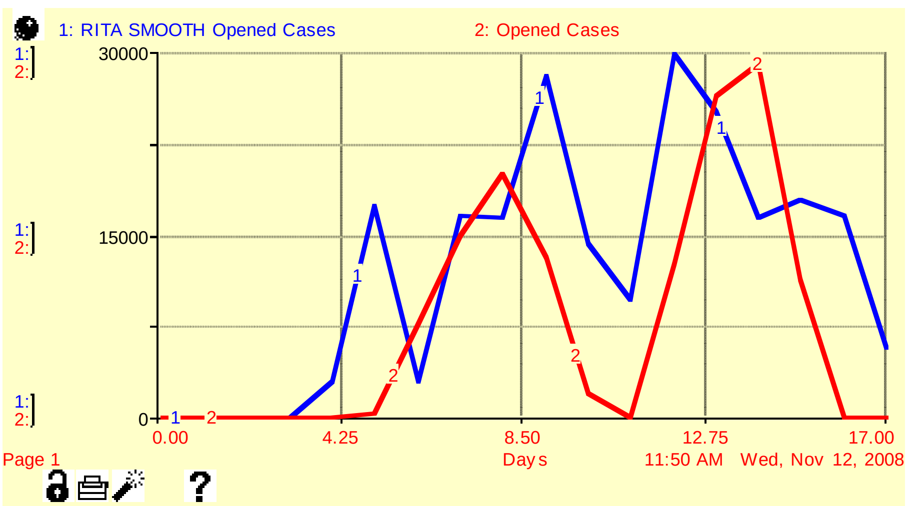


Figure 88. "Opened Cases": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

In real data "Opened Cases" ranged from 0 to nearly 29,994 cases. Simulation shows data ranged from 0 to 29,210 cases.

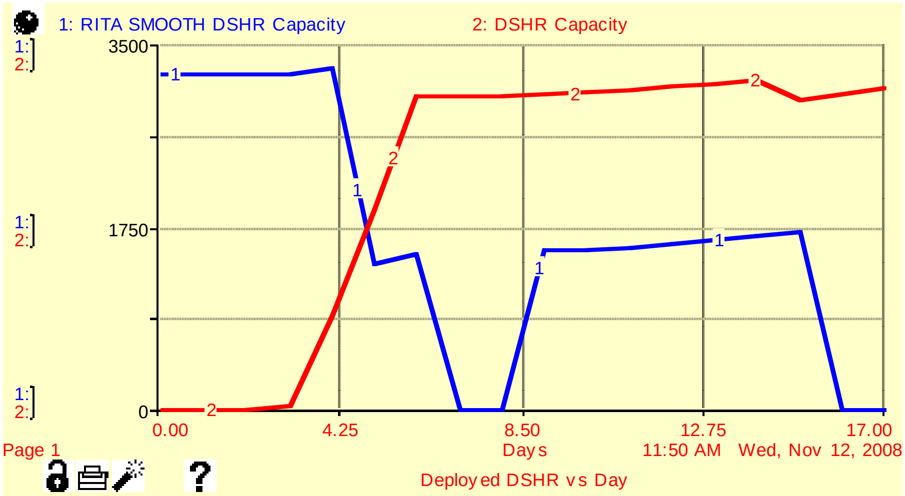


Figure 89. "DSHR Capacity": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

In real data "DSHR Capacity" ranged from 0 to nearly 3351 people. Simulation shows data ranged from 0 to 3,179 people. Here hundreds of the DSHR were already deployed in the field due to the Katrina operation. Of course, for the simulated model all events are separate, and begin from zero staff in the field.

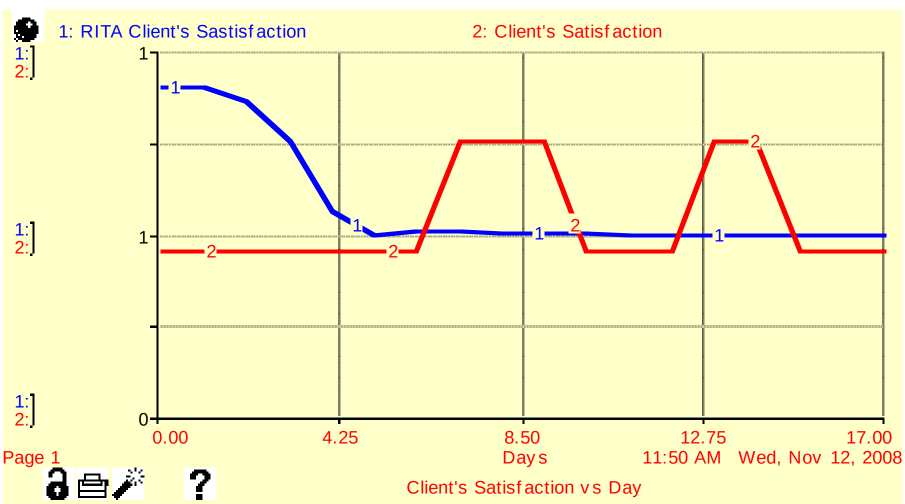


Figure 90. "Client's Satisfaction": Rita Reference Mode vs. Simulation. Author's Elaboration, 2008.

In reality there is not a reference mode for the satisfaction trend in the Rita operation. Therefore, this behavior was assumed. In the Rita reference mode it was presumed that the satisfaction of people diminishes each day during the relief operation, based in news reports of abuse and violence in the ARC shelters.

The simulated model shows that “Client’s Satisfaction” presents several fluctuations over time. It means there were periods during relief operation people experienced a high level of satisfaction: 86.58% maximum value reached (see appendix G).

4.7 EXPERT CONSULTATION

Results were understood, replicated, criticized, and extended by others (Sterman, 2000).This phase is completed showing the results to the major expert of this field in Puerto Rico, Dr. Joaquin Medin and the thesis committee.

5 CONCLUSION

"I have seen too much not to know that the impression of a woman may be more valuable than the conclusion of an analytical reasoner".

-- Arthur Conan Doyle, Sr. --

The chapter is organized as follows: Section 1, presents an overview of the simulation results; Section 2, presents verification of the dynamic hypotheses; Section 3, shows the policy suggestions; Section 4, explains the strategies for ARC managers; and section 5, presents a brief guide for future research.

5.1 OVERVIEW OF THE RESULTS

The purpose of this study was to develop a system dynamics model to mimic how evacuation patterns affect service delivery vis-à-vis the availability of resources to help hurricane victims. Therefore, a computer simulation model named SQRC Model has been created with the aim of helping decision-making process in resource allocation and its effect on the client's satisfaction when a hurricane strikes. The CHAID analysis and the development of this system dynamics model enable decision makers with a dynamic framework to evaluate the performance of relief operations.

Cash donations provide the support for social services organizations. Loss of all or a significant portion of support from funding sources is an indicator of trouble and can lead the non-profit organization to resource reduction. The ARC operates in an uncertain environment, where the careful management of resources and continuous contingency planning is of considerable importance. On the other hand, volunteering is essential to developing, improving, and sustaining ARC. Volunteer activities also enable ARC to maintain its services.

Then, the dynamic framework from this study has the potential for use as an operational and suitable tool for the American Red Cross managers to measure the impact of resource allocation on client's satisfaction; and in turn the impact of the client's satisfaction on cash donations made by non-affected communities and the recruiting of new volunteers.

This framework is also a research tool because in addition to theory-building objective of this study, the SQRC system dynamic model was used to test three dynamics hypothesis to evaluate how changes in the demographic characteristics of the area affected by the disaster; and changes in the clients' satisfaction vis-à-vis the allocation of resources and the timeliness of resource deployment, impact the performance of a relief operation.

The model is comprehensive and simple for understanding a relief operation. It conceptualizes the system involved in a relief process and captures variables related to areas like mass care, individual client services and staff services of the American Red Cross. Its simplicity is established in the limited feedback structures, where the inclusion of a satisfaction loop is the main contribution for the analysis of a relief operation representing how resource allocation affects the client's satisfaction and, at the same time how client's satisfaction impact the performance of the whole system.

It was also determined, with the use of classification trees using CHAID analysis, that external factors define an evacuation decision profile for the affected clients' were household income, race and homeowner status. In addition, to satisfy the victims' immediate needs it is necessary to embrace the client's satisfaction as an evaluation process of any relief operation. Understanding this helps have the victim as the center of the resource allocation considerations while establishing the correct amount of resources needed to be delivered to victims over time, in terms of meals, financial assistance and mental health care.

Even though it is true that this research modeled the hurricane evacuation pattern based on Katrina, the assumption is that at least in the United States people would react in a very similar way when they face a disaster. Relief operations are always executed in the same fashion, and they employ the same kind of resources. With the construction of the SQRC system dynamics model, decision makers would be able to replicate the behavior of different relief operations by just changing the input value of the model's factors (see SQRC Model Interface), because the most important factors that change between relief operations are the characteristics of the affected population (demographic distribution, wealth, area affected, level of the hurricane) which in turn affect the quantity of resources deployed to assist disaster victims.

Therefore, it was determined that fluctuations of the whole system begin when increases and reductions over 50% are made in the original values of the variables that affect the behavior of client's satisfaction. These variables are those related to the key variables "Served Meals", "Delivered Financial Assistance" and "DSHR Capacity", which are:

- Staff Availability Proportion: This is the proportion of the ARC Staff Ready for relief operation to the total Staff.

- Meals Delivered Limit: This is the maximum quantity of food served per DSHR people expressed in units per person.

- Meals Stored: This is the quantity of food reserved for future use during relief operations expressed in units.

- Meals%: Percentage of the cash donations designated for food purchase during the relief operation.

- Financial Assistance %: This is the percentage of the cash donations designated for charging client assistance cards during the relief operation. Client assistant cards are a type of cash cards provided to victims to purchase food or clothes at regular stores, such as Wal-Mart or regular supermarkets.

- Financial Assistance Funds: These are the assets in the form of money that the ARC separates to assist victims in case of a disaster expressed in USD.

- Trained Delay Duration: These are the elapsed numbers of days designated for volunteer training.

Although it is true that non-discretionary factors influence the patterns of the evacuation of victims affected by a disaster. When analyzing the behavior of the system as a whole, and varying sub-system by sub-system (leaving all others constant), it was realized that the *capacity sub-system* is the one that affects the performance of the whole system the most.

Finally, this model is defined as a 15th order model and is constituted of 317 variables classified as follows:

- Number of Stocks: 39
- Number of Flows: 118
- Number of Converters: 160

5.2 VERIFICATION OF THE DYNAMIC HYPOTHESES

Once a functional version of the model was available, 113 different scenarios were simulated in order to learn from the different strategies, as compared with the actual state.

The first scenario followed the strategy of no changes, in order to set a baseline for the other scenarios. It was basically the simulation run with the parameters that defined the Katrina Operation. In chapter 4 an overall analysis of the model results for the time horizon of the operation was provided.

Thirty three scenarios are referred to as the “Increments in Resources”, which represent the strategy of raising, one by one, the amount of resources provided to people in shelters in terms of meals, financial assistance and mental health care. The results of these scenarios show that increasing the goods, one by one, provided to the evacuated people does not cause any changes in the client's satisfaction over time.

Also, the thirty three scenarios which are referred to as the "Reductions in Resources", represent the strategy of decreasing, one by one, the amount of resources provided to people in shelters in terms of meals, financial assistance and mental health care. The results of these scenarios show that a reduction of 50% in the provision of meals would affect by itself the level of satisfaction.

Eleven scenarios are referred to as the "Increments in Combined Resources", represent the strategy of raising a combination of variables related to resources provided to people in shelters in terms of meals, financial assistance and mental health care. The results of these scenarios show that an increase in the provision of meals, financial assistance and mental health care of 75% as combined resources, and reduction, in the same proportion of the elapsed training time of its personnel would allow the system to reach a level of satisfaction of 90.81%. However, this would put the ARC system into stress to achieve this goal and this is not cost-effective for the ARC. Analyzing the behavior of the system showed that this impact in the client's satisfaction largely owed to the reduction in training time, the smaller the DSHR training time the better the timeliness of the deployment of resources then the larger the number of people satisfied because there is a better perception of the quality of the service provided. Therefore, these changes in the subsystem capacity ("served meals", "delivered financial assistance", "mental health care" and "trained delay duration") impact the emergency relief system performance ("client's satisfaction").

Also the eleven scenarios which are referred to as the "Reductions in Combined Resources", represent the strategy of decreasing a combination of variables related to resources provided to people in shelters in terms of meals, financial assistance and mental health care. The results of these scenarios show that a decrease in the provision of meals, financial assistance and mental health care as combined resources by at least 20% would affect negatively the level of satisfaction.

Another scenario, "No DSHR" focused solely on the impact of not having volunteers or employees during the relief operation. The overall impact of this strategy on the whole system is that without DSHR, no meals are served, no cases are opened, no financial assistance is delivered and the lowest client's satisfaction is reached: 45.45%.

Eleven scenarios are referred to as the "Increments in Trained Delay Duration", represent the strategy of rising the amount of time employed in the training of ARC volunteers, employees and staff. Increasing the training time by at least 75% causes a decrease in the client's satisfaction over time.

Also the eleven scenarios which are referred to as the "Reductions in Trained Delay Duration", represent the strategy of decreasing the amount of time employed in the training of ARC volunteers, employees and staff. Decreasing the training time by at least 20% causes an Increase in the client's satisfaction over time.

The last scenario, "Demographics and Profile", represents a variation in one parameter that defines the client's characteristics and the impact on his decision to evacuate. Increasing the type of population with a higher income and specific race and the renter of a property characteristic, increases the number of people who evacuate after, before, during or don't evacuate and in turn the amount of personnel that ARC needs to be ready for deployment in anticipation. Therefore, In this scenario it was determined that Non Hispanic white people who rent their homes and earn an income of more than $10,000 and less than $40,000 cause the increases in the number of people that went to shelters. Running more scenarios changing the proportion of Non White people does not show any significant changes in the number of people that go to shelter or the amount of personnel needed to be ready for deployment in anticipation.

5.3 POLICY SUGGESTIONS

Policy suggestions can be formulated considering the results found in chapter 4 and the test done to the validation of the system dynamic model. Training of employees and volunteers combined with a variation in the quantity of resources provided has an impact on client's satisfaction. One policy could be speed up the ARC rate of training time in anticipation to a disaster event. In this way reducing the delay of DSHR deployed during relief operations leading to an improvement in the level of attention, thus enriching the quality of the service provided to the victims of the disaster.

One of the findings of this research is the analysis of the people's demographics characteristics and profile to determine timing of evacuation. As was demonstrated in the testing of hypothesis 3, a change in the proportion of race, income and homeowner status, changes the amount of people to evacuate. Then, it can be inferred that knowing in advance the demographics and profile of the zone that could be in risk of a potential disaster can lead to a better ARC planning to allocate the right amount of resources to be needed to meet needs of this population with the least delay possible.

5.4 STRATEGIES FOR AMERICAN RED CROSS MANAGERS

In order to achieve and optimal level for the client's satisfaction the SQRC model allows the ARC managers the interactions of strategy, resource allocation and performance measurement. Then, a financial strategy proposed for the ARC is composed for three stages:

A. Strategy Formulation

With the aim of determining an appropriate course of action for achieving ARC objectives and thereby accomplishing its organizational purpose, the following strategies reflect the environmental analysis of a relief operation, leads to fulfillment of ARC organizational mission, and results in reaching ARC objectives:

- **Improve service level**: To increase operating efficiency and timeliness of resources deployment. This strategy would be implemented as part of the enriching in the provision of service speeding up the training time of the DSHR.

- **Improve knowledge of relief operation**: To gather information which leads to a better knowledge of clients' evacuation behavior, capabilities and limitations in order to improve any relief operation.

- **Increase funds:** To obtain additional money for future relief operations or improvement through different sources. Next section shows the analysis of how changes in client's satisfaction cause an impact in cash donations.

  The following graph presents two simulation runs. The X-axis has the time of the simulation for the first 10 days of the relief operation. The Y-axis represents the value of "Cash Donations" both in a good and bad perception scenario at each time.

  The blue line represents the "Cash Donations" behavior when "People in Shelters" have "Good Perceptions" of the service received during relief operation of Katrina hurricane. The red line represents the "Cash Donations" behavior when "People in Shelters" have "Bad Perceptions" of the service received during relief operation of Katrina hurricane

  As it can be seen in Figure 91 and Table 58, when people in shelters have a bad perception of the service received the performance of the whole system is impacted in a negative way, and cash donations decrease. This behavior happens, when the amount of resources required for people in shelters are less than the amount of resources served. Therefore, people's perceptions of the service received is reduced, reaching non acceptable levels, and then the client's satisfaction decreases, and the proportion of people with a bad opinion begin to increase; then the amount of money that non-affected communities donate in case of a disaster decreases. When the amount of resources served to satisfy the people's needs are more than the amount of resources required then the client's satisfaction is impacted in a positive way.

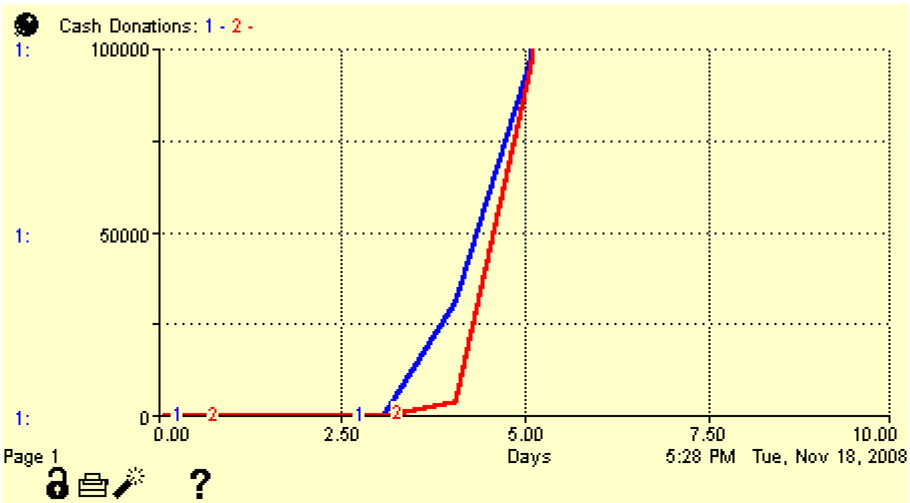


Figure 91. "Cash Donations" Behavior in a Bad News Scenario. Author's Elaboration, 2008.

Table 58. "Cash Donations" Behavior in a Bad News Scenario. Author's Elaboration, 2008.

	Good News Structure	Bad News Structure
Days	**Cash Donations**	**Cash Donations**
0	0	0
1	0	0
2	0	0
3	0	0
4	31,209	3,454
5	96,786	94,017
6	197,026	196,727
7	331,958	331,928
8	501,616	501,585
9	705,936	705,936
10	945,010	945,010

B. Resource Allocation:

Allocating resources is perhaps on of the most challenging tasks that ARC must face. Targeting relief operation resources to populations affected by a disaster is a major purpose of the ARC resource allocation.

This raises the questions of not only how many resources should be allocated but also how fast. Those decisions will have to be based on an understanding of the causes and mechanisms generating the relationship between service delivery and client's satisfaction.

The SQRC Model shows that targeting services to maintain an acceptable level in client's satisfaction during each stage of the relief operation can made just reducing below a 50% the provision of meals to people inside shelters. This finding was the most surprisingly fact a ARC manager must know, because the general tendency is to think that is the reduction in financial assistance what causes dissatisfaction in people in national disaster times.

C. Performance Measurement:

Measuring performance is a key element for the ARC. It helps to determine the effectiveness and efficiency of selected strategies, assists in setting priorities, and improves relief operation performance.

The major challenge for the ARC is the development of measures of outcomes, of the impacts of the service provided to people in shelters on the public opinion.

ARC Performance measures can be derived from an understanding of the logic of the relief operation, that is, the relations of cause and influence that connect client's satisfaction to resource allocation. In this kind of operations these relations are always complex. The SQRC dynamic model helps to identify these relations. It also provides a much more detailed picture of the relief operation system performance.

5.5 FUTURE RESEARCH

This model is an important contribution for disaster relief organization. The model sets the ground for multiple possibilities of future researches.

Although this model is specific for the American Red Cross relief operations, it can be generalized to other relief organization knowing the inside of each of them. In this way the model can be modify and programmed to attend the requirements and activities of the new relief organization behavior.

Studies may be developed with the analysis of data of new hurricane events and use the results to analyze the emergency relief performance for a particular relief operation.

Another possibility is to increase the scope of the model contemplating more functions inside the SQRC model and link the other ARC functions together in order to simulate the dynamics of the ARC response activities.

This study is specific for the analysis of relief operation in case of hurricane disaster. As the variable “Hurricane Level” is just affecting the recruiting of “New Volunteers”, therefore, making changes in the programming of “Hurricane Level” allows the decision maker analyze another kind of disaster event such as earthquakes.

Communications breakdowns happen during Katrina. Many of these malfunctions left many emergency response personnel with no way of communicating with one another during a time when coordination of rescue and relief efforts was most important. This could be another research opportunity, since the SQRC model does not contemplate communication of the ARC with other Non-profits organizations inside its boundaries.

Appendix A – American Red Cross Survey Questions, KPD-Katrina Panel Data

Next, and in detail, are the questions related to the response operation made by the American Red Cross to clients of the Katrina and Rita Hurricane in August, 2005 and embraced specifically information associated with client's resources before the event, whether the clients paid attention to the evacuation order, among others things.

1. Where were you living when the storm hit: in New Orleans, on the outskirts of New Orleans, elsewhere in Louisiana or somewhere else?
    - No answer
    - New Orleans
    - Outskirts of New Orleans
    - Elsewhere in Louisiana
    - Mississippi
    - Another state
    - Don't know
    - Refused

2. What part of New Orleans are you from?
    - No Answer
    - Ninth Ward
    - Viavant/Venetian Isles
    - New Orleans East
    - Algiers
    - New Aurora/English Turn
    - Bywater/Marigny/St. Claude/St. Roch/Desire
    - Gentilly
    - Lakeview
    - Mid-City
    - French Quarter/Central Business District
    - Central City/Garden District
    - Uptown/Carrollton
    - Don't know
    - Refused

3. How long have you lived in New Orleans?
    - No Answer
    - Less than a year
    - Whole Life
    - Don't know
    - Refused

4. Were you living in a home that you or your family owned, were you renting a house or apartment, living in a facility such as a retirement home, or somewhere else?
    - No Answer

- Home owned by self/family
- Renting house/apartment
- Living in a facility
- Somewhere else
- Don't know
- Refused

5. As far as you know, was the place you were living destroyed by the hurricane or flood, seriously damaged but not destroyed, or not seriously damaged?
   - No Answer
   - Destroyed
   - Seriously damaged by not destroyed
   - Not seriously damaged
   - Don't know
   - Refused

6. Before the hurricane hit, did you yourself hear that an order to evacuate had been given, or not?
   - No Answer
   - Yes
   - No
   - Don't know
   - Refused

7. Regardless of whether you heard it, do you happen to know if the government issued an evacuation order for your area, or not?
   - No Answer
   - Yes
   - No
   - Don't know
   - Refused

8. Where did you get most of your news about the evacuation order; from TV, radio, from the police, or from a friend or family member?
   - No Answer
   - TV
   - Radio
   - Police
   - Friend/Family member
   - Somewhere else
   - Don't know
   - Refused

9. Did the evacuation message you heard give clear information about how to evacuate, or not?
   - No Answer
   - Yes
   - No
   - Don't know

- Refused

10. And did you yourself evacuate before the storm hit, or not?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

11. Aa. For each, tell me if it is a reason why you, personally, did not evacuate: I did not have a car or a way to leave.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

11. Ab. For each, tell me if it is a reason why you, personally, did not evacuate: I was physically unable to leave.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

11. Ac. For each, tell me if it is a reason why you, personally, did not evacuate: I had to care for someone who was physically unable to leave.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

11. Ad. For each, tell me if it is a reason why you, personally, did not evacuate: I waited too long.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

11. Ae. For each, tell me if it is a reason why you, personally, did not evacuate: I thought the storm and its aftermath would not be as bad as it was.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

11. Af. For each, tell me if it is a reason why you, personally, did not evacuate: I worried that my possessions would be stolen or damaged if I left
- No Answer
- Yes
- No
- Don't know
- Refused

11. Ag. For each, tell me if it is a reason why you, personally, did not evacuate: I didn't want to leave my pet
- No Answer
- Yes
- No
- Don't know
- Refused

11. Ah. For each, tell me if it is a reason why you, personally, did not evacuate: I just didn't want to leave.
- No Answer
- Yes
- No
- Don't know
- Refused

11. B. Which of these was the biggest reason why you did not leave?
- No Answer
- I did not have a car or a way to leave
- I was physically unable to leave
- I had to care for someone who was physically unable to leave
- I waited too long
- I thought the storm and aftermath wouldn't be as bad as it was
- I worried that possessions would be stolen/damaged if I left
- I didn't want to leave my pet
- I just didn't want to leave

12. Looking back do you think you could have found a way to leave before the storm hit, or was there no way for you to leave?
- No Answer
- Yes, could have found a way to leave
- No, could not have found a way
- Don't know
- Refused

13. a. Please tell me if any of the following apply to your situation before you came to this shelter: I spent time inside the Superdome in New Orleans.
- No Answer
- Yes
- No
- Don't know

- Refused

13. b. Please tell me if any of the following apply to your situation before you came to this shelter: I spent time inside the Convention Center in New Orleans.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

13. c. Please tell me if any of the following apply to your situation before you came to this shelter: I tried to get into the Superdome or Convention Center but was not able to.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

13. d. Please tell me if any of the following apply to your situation before you came to this shelter: I spent at least a day living outside on a street or overpass.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

13. e. Please tell me if any of the following apply to your situation before you came to this shelter: I was trapped in my home and had to be rescued.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

14. For how many days were you trapped in your home?
    - No Answer
    - Less than one day
    - Don't know
    - Refused

15. Who eventually rescued you?
    - No Answer
    - Police or firefighters
    - Coast Guard, national guard or military
    - Friends or neighbors
    - Or did you rescue yourself
    - Other
    - Don't know

- Refused

16. a. Since the hurricane hit, has there been a time when you: Didn't have enough fresh water to drink.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

16. b. Since the hurricane hit, has there been a time when you: Didn't have enough food to eat.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

16. c. Since the hurricane hit, has there been a time when you: Didn't have the prescription drugs or medicines that you needed.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

16. d. Since the hurricane hit, has there been a time when you: Were threatened by violence.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

16. e. Since the hurricane hit, has there been a time when you: Needed medical care and couldn't get it.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

17. How many days have you been in Houston?
    - No Answer
    - Less than one day
    - Don't know
    - Refused

17. a. How did you get to Houston: Were you brought to Houston as part of the government evacuation effort, did you get here on your own, or some other way?
- No Answer
- Brought to Houston as part of the government evacuation effort
- Got to Houston on your own
- Some other way
- Don't know
- Refused

18. How many days have you been at this shelter?
- No Answer
- Less than one day
- Don't know
- Refused

19. How would you describe conditions at this shelter, excellent, good, not-so-good or poor?
- No Answer
- Excellent
- Good
- Not-so-good
- Poor
- Don't know
- Refused

20. a. Please tell me if any of the following words describe your feelings about your future: Frightened.
- No Answer
- Yes
- No
- Don't know
- Refused

20. b. Please tell me if any of the following words describe your feelings about your future: Angry.
- No Answer
- Yes
- No
- Don't know
- Refused

20. c. Please tell me if any of the following words describe your feelings about your future: Grateful.
- No Answer
- Yes
- No
- Don't know
- Refused

20. d. Please tell me if any of the following words describe your feelings about your future: Depressed.

- No Answer
- Yes
- No
- Don't know
- Refused

20. e. Please tell me if any of the following words describe your feelings about your future: Relieved.

- No Answer
- Yes
- No
- Don't know
- Refused

20. f. Please tell me if any of the following words describe your feelings about your future: Hopeful

- No Answer
- Yes
- No
- Don't know
- Refused

21. Now thinking about your immediate family, that is, the people who lived with you in your home before the hurricane. Which best describes your current situation:

- No Answer
- All my immediate family is with me in this shelter
- I am separated..., but I know where they are
- Some members of my immediate family are still missing
- Don't know
- Refused

22. Aside from your immediate family, are any of your other close relatives or friends still missing, or have they all been accounted for?

- No Answer
- Still missing
- All accounted for
- Don't know
- Refused

23. Are you supposed to be taking any prescription drugs or medicines prescribed by a doctor, or not?

- No Answer
- Yes
- No
- Don't know
- Refused

24. Are you having a problem getting the prescription drugs you need to take, or not?

- No Answer
- Yes
- No
- Don't know
- Refused

25. Have you experienced any health problems or injuries as a result of the hurricane and flooding, or not?

- No Answer
- Yes
- No
- Don't know
- Refused

26. Were they serious, or not?

- No Answer
- Yes, serious
- No, not serious
- Don't know
- Refused

27. Are these problems currently being taken care of, or not?

- No Answer
- Yes
- No
- Don't know
- Refused

28. Aa. Are you trying to do any of the following things right now? Find family or friends.

- No Answer
- Yes
- No
- Not Applicable
- Don't know
- Refused

28. Ab. Are you trying to do any of the following things right now? Get a job.

- No Answer
- Yes
- No
- Not Applicable
- Don't know
- Refused

28. Ac. Are you trying to do any of the following things right now? Find a place to live.

- No Answer
- Yes
- No

- Not Applicable
- Don't know
- Refused

28. Ad. Are you trying to do any of the following things right now? Get medical care.
- No Answer
- Yes
- No
- Not Applicable
- Don't know
- Refused

28. Ae. Are you trying to do any of the following things right now? Enroll your children in school.
- No Answer
- Yes
- No
- Not Applicable
- Don't know
- Refused

28. B. Which of those is most important to you right now?
- No Answer
- Find family or friends
- Get a job
- Find a place to live
- Get medical care
- Enroll your children in school
- Don't know
- Refused

29. What best describes your situation?
- No Answer
- I have insurance to cover most of my losses
- I have insurance to cover some of my losses
- I have no insurance
- Don't know
- Refused

30. a. Do you have any of the following? A bank savings or checking account from which you can withdraw money.
- No Answer
- Yes
- No
- Don't know
- Refused

30. b. Do you have any of the following? Relatives or friends you can move in with until you are back on your feet.

- No Answer
- Yes
- No
- Don't know
- Refused

30. c. Do you have any of the following? A working cell phone with you.
- No Answer
- Yes
- No
- Don't know
- Refused

30. d. Do you have any of the following? Any useable credit cards with you, other than any debit card you may have recently received from the government or the Red Cross.
- No Answer
- Yes
- No
- Don't know
- Refused

30. e. Do you have any of the following? Enough clothes with you.
- No Answer
- Yes
- No
- Don't know
- Refused

31. How long do you expect to be living in a shelter like this: A few more days, a few more weeks, a few months, or don't you have any idea?
- No Answer
- A few more days
- A few more weeks
- A few months
- DK/Do not have any idea
- Refused

32. As things stand now, do you plan to:
- No Answer
- Stay in a shelter until you can move back home permanently
- Stay in a shelter until you can move elsewhere permanently
- Move somewhere temporarily until able to move permanently
- Don't know
- Refused

33. a. Do you plan to temporarily: Move in with relatives or friends?
- No Answer
- Yes

- No
- Don't know
- Refused

33. b. Do you plan to temporarily: Move in with a family that has volunteered to share space
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

33. c. Do you plan to temporarily: Rent a place in the Houston area?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

33. d. Do you plan to temporarily: Rent a place somewhere else?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

34. Do you want to eventually move back to your hometown, or do you want to permanently relocate somewhere else?
    - No Answer
    - Move back to hometown
    - Permanently relocate
    - Don't know
    - Refused

35. Do you want to eventually move back into your old home, move to another home in your old neighborhood, or move to a different part of town?
    - No Answer
    - Move back to old home
    - Move to another house in old neighborhood
    - Move to different part of town
    - Don't know
    - Refused

36. Would that be somewhere else back in your home state, somewhere in the Houston area, somewhere else in Texas, or in another state?
    - No Answer
    - Back in home state
    - In Houston area
    - In Texas

- Another state
- Don't know
- Refused

37. Just your best guess, about how long do you think it will be before you can move there: a few weeks, a few months, six months to a year, or longer than that?
    - No Answer
    - A few weeks
    - A few months
    - Six months to a year
    - Longer
    - Don't know
    - Refused

38. Which comes closer to your view about how the government responded to the hurricane and flooding.
    - No Answer
    - The response was too slow and there's no excuse
    - Time it took to respond was reasonable under circumstances
    - Don't know
    - Refused

39. Aa. Did any of the following help you during the flood and evacuation: New Orleans police or fire department or other city agencies?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

39. Ab. Did any of the following help you during the flood and evacuation: National Guard, Coast Guard, or Military?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

39. Ac. Did any of the following help you during the flood and evacuation: State police or other state agencies?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

39. Ad. Did any of the following help you during the flood and evacuation: Officials from federal agencies such as Homeland Security or FEMA, the Federal Emergency Management Agency?

- No Answer
- Yes
- No
- Don't know
- Refused

39. Ae. Did any of the following help you during the flood and evacuation: Private organizations such as the Red Cross, the Salvation Army or other groups?

- No Answer
- Yes
- No
- Don't know
- Refused

39. B. Of the organizations you named, who helped you the most?

- No Answer
- New Orleans police or fire department or other city agencies
- National Guard, Coast Guard, or Military
- State police or other state agencies
- Officials from federal agencies (Homeland Security or FEMA)
- Private organizations (Red Cross, Salvation Army or others)
- Don't know
- Refused

40. Do you approve or disapprove of the way George W. Bush has handled the situation caused by Hurricane Katrina?

- No Answer
- Approve
- Disapprove
- Don't know
- Refused

41. Do you approve or disapprove of the way Governor Kathleen Babineux Blanco has handled the situation caused by Hurricane Katrina?

- No Answer
- Approve
- Disapprove
- Don't know
- Refused

42. Do you approve or disapprove of the way New Orleans Mayor Ray Nagin has handled the situation caused by Hurricane Katrina?

- No Answer
- Approve
- Disapprove
- Don't know

- Refused

43. Considering everything, who do you blame most for the problems that occurred due to the hurricane and flooding: the Federal Government, the state of Louisiana, the city of New Orleans, or someone else?
    - No Answer
    - The federal government
    - The state of Louisiana
    - The city of New Orleans
    - Someone else
    - All equally
    - Nobody
    - Don't know
    - Refused

44. Do you think the Federal Government would've responded more quickly to rescue people trapped by floodwaters if more of them had been wealthier & white rather than poorer & black, or do you think race & poverty didn't effect the speed of the rescue effort?
    - No Answer
    - Yes, would have responded quicker
    - No, race and poverty had no effect
    - Don't know
    - Refused

45. Based on your own experiences, do you think the hurricane brought out the best in people or the worst in people?
    - No Answer
    - Best in people
    - Worst in people
    - Both
    - Don't know
    - Refused

46. Has your experience made you feel like the government cares about people like you, or has it made you feel like the government doesn't care?
    - No Answer
    - Government cares
    - Government does not care
    - Don't know
    - Refused

47. How important a role has religion played in helping you get through these past two weeks?
    - No Answer
    - Very important
    - Somewhat important
    - Not too important
    - Not at all important

- Don't know
- Refused

48. Has this experience strengthened your religious faith, weakened your faith, or has it made no difference to your religious faith?
    - No Answer
    - Strengthened religious faith
    - Weakened religious faith
    - No difference
    - Not religious/Don't believe in God
    - Don't know
    - Refused

49. How old are you?
    - No Answer
    - Don't know
    - Refused

50. What is your Marital status?
    - No Answer
    - Married
    - Living as married
    - Single, never married
    - Separated
    - Divorced
    - Widowed
    - Don't know
    - Refused

51. What was your total annual household income before taxes last year?
    - No Answer
    - Under $10,000
    - $10, 000 to under $20,000
    - $20,000 to under $30,000
    - $30,000 to under $40,000
    - $40,000 to under $50,000
    - $50,000 or more
    - Don't know
    - Refused

52. Do you have any children under the age of 18?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

53. Are any of them here in the shelter with you, or not?
    - No Answer

- Yes
- No
- Don't know
- Refused

54. Are you, yourself, of Hispanic or Latino background, such as Mexican, Puerto Rican, Cuban, or some other Latin American background?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

55. What is your race? Are you white, black, Asian, or some other race?
    - No Answer
    - White
    - Black
    - Asian
    - Some other race
    - Don't know
    - Refused

56. What is the last grade or class that you completed in school?
    - No Answer
    - None, or grade 1-8
    - High school incomplete (grades 9-11)
    - High school grad
    - GED
    - Business, technical, or vocational school after high school
    - Some college, no 4-year degree
    - College graduate
    - Post-graduate training/professional schooling after college
    - Refused

57. Before the hurricane, were you yourself employed full-time, part-time, or not at all?
    - No Answer
    - Full time
    - Part time
    - Not at all
    - Don't know
    - Refused

58. How easy do you think it will be to get another job similar to the one you had before the hurricane? Do you think it will be very easy, somewhat easy, not too easy, or not easy at all?
    - No Answer
    - Very easy
    - Somewhat easy
    - Not too easy

- Not easy at all
- Don't know
- Refused

59. Were you retired, a homemaker, a student, or unemployed?
    - No Answer
    - Retired
    - A homemaker
    - A student
    - Unemployed
    - Don't know
    - Refused

60. Prior to this disaster, did you or your household have a disaster or emergency kit containing a three day supply of staples like food, water, clothing, medical supplies and other equipment?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

61. Prior to this disaster, did you or your household create a family emergency, where you would go if you had to evacuate, and where you would meet up with family members?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

62. a. Has a doctor or health professional ever told you that you had: Heart disease?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

62. b. Has a doctor or health professional ever told you that you had: Hypertension.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

62. c. Has a doctor or health professional ever told you that you had: Diabetes.
    - No Answer
    - Yes
    - No

- Don't know
- Refused

62. d. Has a doctor or health professional ever told you that you had: Asthma or other lung disease.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

62. e. Has a doctor or health professional ever told you that you had: A physical disability.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

62. f. Has a doctor or health professional ever told you that you had: Cancer.
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

63. Are you, covered by any form of health insurance or health plan or did you not have health insurance at the time of the hurricane?
    - No Answer
    - Yes, covered
    - No, not covered
    - Don't know
    - Refused

64. Which of the following is your main source of health insurance coverage?
    - No Answer
    - Private insurance
    - Medicare
    - Medicaid or some other government program
    - Don't know
    - Refused

65. Before the hurricane, where did you mainly get your health care?
    - No Answer
    - At a hospital
    - At a clinic or health center
    - At a doctor's office

    - No health care

- Don't know
- Refused

66. What is the name of the hospital/clinic?
    - No Answer
    - Ascension Hospital
    - Charity Hospital
    - Children's Hospital
    - Columbia Lakeland Medical Center
    - De Paul-Tulane Behavioral Health
    - East Lake Hospital
    - Jo Ellen Smith Medical Center
    - Medical Center Of Louisiana
    - Memorial Medical Center
    - Methodist Health System Foundation
    - New Orleans Adolescent Hospital
    - Pendleton Memorial Meth Hospital
    - River Oaks Hospital
    - St Charles General Hospital
    - St Claude Medical Center Hospital
    - Touro Infirmary
    - Tulane University Medical Center
    - VA or US Veterans Medical Center
    - University Hospital
    - Vencor Hospital
    - West Bank Behavioral Health
    - Other
    - Don't know
    - Refused

67. Were any members of your family, neighbors or close friends injured in the storm or flooding, or not?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

68. Were any members of your family, neighbors or close friends killed during the storm or flooding, or not?
    - No Answer
    - Yes
    - No
    - Don't know
    - Refused

69. Looking ahead, do you think you will ever fully recover from the hurricane, or don't you think you will ever fully recover?
    - No Answer

- Yes, think will recover
- No, won't ever fully recover
- Don't know
- Refused

70. Gender.
    - No Answer
    - Male
    - Female
    - Don't know
    - Refused

71. Interviewer Code where the interview was conducted.
    - No Answer
    - Astrodome
    - Reliant Center
    - Brown Convention Center
    - A Surrounding Red Cross Shelter
    - Don't know
    - Refused

Religion Importance

- Very important
- Not important
- Not applicable or refuse

Age

- 18-34
- 35-44
- 45-54
- 55+

Annual HH Income

- Under $10,000
- $10, 000 to under $20,000
- $20,000 to under $40,000
- $40,000 to under $50,000
- Don't know

Education

- Less than HS
- HS or GED
- Educ after HS

Couple with Child

- No
- Yes

Single or Married

- Married or Like

- Single
- Domestic Partner

Couple without Child
- No
- Yes

Single with Child
- No
- Yes

No children
- No
- Yes

Live in New Orleans Category
- <5 years
- >5 years
- >10 years
- >20 years
- >30 years
- >40 years
- 50 years or more

Days trapped in home Category
- <1 day
- >1 day
- >5 days
- >10 days

Days in Houston category
- >=1 day
- >= 5 days
- >= 10 days
- >= 20 days

Days in Shelter Category
- >1 day
- >=5 days
- >= 10 days
- >= 20 days

Appendix B – American Red Cross Survey Questions, ICP2-Indicators of Chapters Performance and Potentials

Next, and in detail, are the questions related to response operation made by the American Red Cross to clients of the Katrina and Rita Hurricane in August, 2005 and included information associated with service quality, customer satisfaction, partners' opinion and agreements, among others.

1. Q1515 GENDER.
   - NA
   - Male
   - Female

2. Q1525 Would you say that the help you received from the Red Cross was more than you expected, about what you expected or less than you expected?
   - NA
   - More than you expected
   - About what you expected
   - Less than you expected
   - Not sure what to expect (vol)
   - Not sure (vol)
   - Decline to answer (vol)

3. Q1530 How would you rate the American Red Cross on meeting your most serious needs?
   - NA
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Not sure (Vol)
   - Decline to answer (vol)

4. Q1541_1 To what extend do you agree or disagree with ...? - You felt the Red Cross staff treated you with respect.
   - NA
   - Strongly disagree
   - Disagree
   - Not Agree, Not Disagree
   - Agree
   - Strongly agree
   - Not sure (vol)
   - Decline to answer [vol]

5. Q1541_2 To what extend do you agree or disagree with ...? - You felt Red Cross staff treated you with fairness.
   - NA
   - Strongly disagree
   - Disagree
   - Not Agree, Not Disagree
   - Agree
   - Strongly agree
   - Not sure (vol)
   - Decline to answer [vol]

6. Q1541_3 To what extend do you agree or disagree with ...? - You felt the American Red Cross strived to meet the human needs of yourself and other victims of this disaster.
   - NA
   - Strongly disagree
   - Disagree
   - Not Agree, Not Disagree
   - Agree
   - Strongly agree
   - Not sure (vol)
   - Decline to answer [vol]

7. Q1541_4 To what extend do you agree or disagree with ...? - You felt the American Red Cross handled itself with integrity.
   - NA
   - Strongly disagree
   - Disagree
   - Not Agree, Not Disagree
   - Agree
   - Strongly agree
   - Not sure (vol)
   - Decline to answer [vol]

8. Q1545 If you could change one thing about your experience in applying for disaster help from the Red Cross, what would you change?
   - NA
   - Less waiting time/no standing in lines
   - More help stations in the affected areas
   - Having more help available
   - A faster/easier way to apply/get assistance
   - Better organizational methods
   - Getting important information to the public more efficiently
   - More phone lines available
   - Less time on the phone waiting on hold
   - More options available to apply for aid
   - Responding to affected areas faster/coming sooner
   - Better fraud control/detection
   - Have more funds available

- Have more professionals on hand to coordinate/answer question
- We did not have any problems
- Did not apply/Did not need
- Way they treated us/Disrespectful staff
- Other
- None/Nothing
- Not sure/Don't know
- Decline to answer

9. Q1045 In what year were you born?

10. Q1046 Age Computed From Birth Year.

11. Q1055 Do you consider yourself...?
    - NA
    - White
    - Black
    - Asian or Pacific Islander
    - Native American or Alaskan native
    - Mixed racial background
    - Other race
    - Hispanic
    - African American
    - First Nation/Native Canadian
    - South Asian
    - Chinese
    - Korean
    - Japanese
    - Other Southeast Asian
    - Filipino
    - Arab/West Asian
    - Decline to answer
    - Unknown

12. Q405 In what state were you living during Hurricane Katrina?
    - NA
    - Alabama
    - Alaska
    - Arizona
    - Arkansas
    - California
    - Colorado
    - Connecticut
    - Delaware
    - District of Columbia
    - Florida
    - Georgia
    - Hawaii

- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West Virginia
- Wisconsin
- Wyoming
- Armed Forces – Americas
- Armed Forces - Africa, Canada, Europe and Middle East
- Armed Forces – Pacific
- American Samoa
- Federated States of Micronesia
- Guam
- Marshall Islands
- Northern Mariana Islands
- Puerto Rico

- Palau
- Virgin Islands
- Unknown

13. Q410 In what state are you currently residing?
    - NA
    - Alabama
    - Alaska
    - Arizona
    - Arkansas
    - California
    - Colorado
    - Connecticut
    - Delaware
    - District of Columbia
    - Florida
    - Georgia
    - Hawaii
    - Idaho
    - Illinois
    - Indiana
    - Iowa
    - Kansas
    - Kentucky
    - Louisiana
    - Maine
    - Maryland
    - Massachusetts
    - Michigan
    - Minnesota
    - Mississippi
    - Missouri
    - Montana
    - Nebraska
    - Nevada
    - New Hampshire
    - New Jersey
    - New Mexico
    - New York
    - North Carolina
    - North Dakota
    - Ohio
    - Oklahoma
    - Oregon
    - Pennsylvania
    - Rhode Island
    - South Carolina
    - South Dakota

- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West Virginia
- Wisconsin
- Wyoming
- Armed Forces – Americas
- Armed Forces - Africa, Canada, Europe and Middle East
- Armed Forces – Pacific
- American Samoa
- Federated States of Micronesia
- Guam
- Marshall Islands
- Northern Mariana Islands
- Puerto Rico
- Palau
- Virgin Islands
- Unknown

14. Q415 Where are you currently residing?
    - NA
    - With family/friends
    - In a temporary shelter
    - In a permanent shelter
    - In your own home
    - Somewhere else
    - Not sure (vol)
    - Decline to answer (vol)

15. Q910 Do you plan on staying for the long term in the same state/area in which you are currently living, or are you there only temporarily until you can go back home?
    - NA
    - Staying in new state/area permanently
    - Staying in new state/area temporarily
    - Did not go to another state/area
    - Not sure (vol)
    - Decline to answer (vol)

16. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO By yourself
    - By yourself

17. Q1595 Who were you with when the hurricane hit?
    - NA

- NO TO With your spouse
- With your spouse

18. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO With your children
    - With your children

19. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO With an elderly parent
    - With an elderly parent

20. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO With another family member
    - With another family member

21. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO Someone else
    - Someone else

22. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO Not sure (vol)
    - Not sure (vol)

23. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO Decline to answer (vol)
    - Decline to answer (vol)

24. Q1595 Who were you with when the hurricane hit?
    - NA
    - NO TO NA
    - NA

25. Q855 Did you receive disaster assistance from the American Red Cross because of this disaster?
    - NA
    - Yes
    - No
    - Not sure (vol)
    - Decline to answer (vol)

26. Q170 Indicate the country you consider your primary country of citizenship.
    - NA
    - Afghanistan

- Albania
- Algeria
- American Samoa
- Andorra
- Angola
- Anguilla
- Antarctica
- Antigua and Barbuda
- Argentina
- Armenia
- Aruba
- Ascension Island
- Australia
- Austria
- Azerbaijan
- Azores
- Bahamas
- Bahrain
- Balearic Islands
- Bangladesh
- Barbados
- Belarus
- Belgium
- Belize
- Benin
- Bermuda
- Bhutan
- Bolivia
- Bosnia and Herzegovina
- Botswana
- Bouvet Island
- Brazil
- British Indian Ocean Territory
- Brunei
- Bulgaria
- Burkina Faso
- Burma
- Burundi
- Cambodia
- Cameroon
- Canada
- Canary Islands
- Cape Verde
- Central African Republic
- Chad
- Chile
- China
- Christmas Island

- Cocos (Keeling) Islands
- Colombia
- Comoros
- Congo
- Cook Islands
- Costa Rica
- Croatia
- Cuba
- Cyprus
- Czech Republic
- Denmark
- Djibouti
- Dominica
- Dominican Republic
- East Timor
- Ecuador
- Egypt
- El Salvador
- Equatorial Guinea
- Eritrea
- Estonia
- Ethiopia
- Falkland Islands
- Faroe Islands
- Fiji
- Finland
- France
- Metropolitan France
- French Guiana
- French Polynesia
- French Southern Territories
- Gabon
- Gambia
- Georgia
- Germany
- Ghana
- Gibraltar
- Cayman Islands
- Greece
- Unknown
- Greenland
- Grenada
- Guadeloupe
- Guam
- Guatemala
- Guernsey
- Guinea
- Guinea-Bissau

- Guyana
- Haiti
- Heard and McDonald Islands
- Holy See (Vatican City State)
- Honduras
- Hong Kong (China)
- Hungary
- Iceland
- India
- Indonesia
- Iran
- Iraq
- Isle of Man
- Israel
- Italy
- Ivory Coast
- Jamaica
- Japan
- Jersey
- Jordan
- Kazakhstan
- Kenya
- Kiribati
- Kuwait
- Kyrgyzstan
- Laos
- Latvia
- Lebanon
- Lesotho
- Liberia
- Libya
- Liechtenstein
- Lithuania
- Luxembourg
- Macau
- Macedonia
- Madagascar
- Madeira Island
- Malawi
- Malaysia
- Maldives
- Mali
- Malta
- Marshall Islands
- Martinique
- Mauritania
- Mauritius
- Mayotte

- Mexico
- Micronesia
- Moldova
- Monaco
- Mongolia
- Montserrat
- Morocco
- Mozambique
- Namibia
- Nauru
- Nepal
- Netherlands
- Netherlands Antilles
- New Caledonia
- New Zealand
- Nicaragua
- Niger
- Nigeria
- Niue
- Norfolk Island
- North Korea
- Northern Mariana Islands
- Norway
- Oman
- Pakistan
- Palau
- Panama
- Papua New Guinea
- Paraguay
- Peru
- Philippines
- Pitcairn
- Poland
- Portugal
- Puerto Rico
- Qatar
- Republic of South Africa
- Reunion
- Romania
- Russia
- Rwanda
- Saint Kitts and Nevis
- Saint Lucia
- Saint Vincent and the Grenadines
- Samoa
- San Marino
- Sao Tome and Principe
- Saudi Arabia

- Senegal
- Seychelles
- Sierra Leone
- Singapore
- Slovakia
- Slovenia
- Solomon Islands
- Somalia
- South Georgia and Sandwich Isl.
- South Korea
- Spain
- Sri Lanka
- St. Helena
- St. Pierre and Miquelon
- Sudan
- Surinam
- Svalbard
- Swaziland
- Sweden
- Switzerland
- Syria
- Taiwan
- Tajikistan
- Tanzania
- Thailand
- Togo
- Tokelau
- Tonga
- Trinidad and Tobago
- Tunisia
- Turkey
- Turkmenistan
- Turks and Caicos Islands
- Tuvalu
- U.S. Minor Outlying Islands
- Uganda
- Ukraine
- United Arab Emirates
- United Kingdom
- United States
- Uruguay
- Uzbekistan
- Vanuatu
- Venezuela
- Vietnam
- Virgin Islands (British)
- Virgin Islands (U.S.)
- Wallis and Futuna Islands

- Western Sahara
- Yemen
- Yugoslavia
- Zaire
- Zambia
- Zimbabwe
- Other Asia/Pacific nation (excluding Hawaii)
- Australia or New Zealand
- Other European nation
- Other Latin American or South American nation
- Other Middle East nation
- Other Caribbean nation
- Other African nation
- England
- Scotland
- Wales
- Korea
- Holland
- Great Britain
- Democratic Republic of Congo
- Cote D'Ivoire
- Europa Island
- Glorioso Island
- Juan De Nova Island
- Gaza Strip
- West Bank
- Midway Island
- Wake Island
- Montenegro
- Serbia
- Kosovo and Metohija
- Johnston Atoll
- Northern Ireland
- Ireland (Republic of)
- Decline to answer
- Other country

27. Q1000 Do you have any physical disabilities/special needs?
    - NA
    - Yes
    - No
    - Decline to answer

28. Q1005 Where did you live before Hurricane Katrina struck?
    - NA
    - In a single-family home.
    - In a multi-family home (apartment, condo, etc.)
    - Decline to answer (vol)

29. Q1010 Do or did you own any pets?
    - NA
    - Yes
    - No
    - Decline to answer (vol)

30. Q202 What is your marital status?
    - NA
    - Single, never married
    - Married
    - Divorced
    - Separated
    - Widowed
    - Living with partner
    - Decline to answer (vol)

31. Q204 Adults In Household.

32. Q206 Children In Household.

33. Q210 What is your employment status?
    - NA
    - NO TO Employed full time
    - Employed full time

34. Q210 What is your employment status?
    - NA
    - NO TO Employed part time
    - Employed part time

35. Q210 What is your employment status?
    - NA
    - NO TO Self-employed
    - Self-employed

36. Q210 What is your employment status?
    - NA
    - NO TO Not employed, but looking for work
    - Not employed, but looking for work

37. Q210 What is your employment status?
    - NA
    - NO TO Not employed and not looking for work
    - Not employed and not looking for work

38. Q210 What is your employment status?
    - NA
    - NO TO Retired

- Retired

39. Q210 What is your employment status?
    - NA
    - NO TO Student
    - Student

40. Q210 What is your employment status?
    - NA
    - NO TO Homemaker
    - Homemaker

41. Q210 What is your employment status?
    - NA
    - NO TO Decline to answer (vol)
    - Decline to answer (vol)

42. Q210 What is your employment status?
    - NA
    - NO TO NA
    - NA

43. Q209_1 Age Child 1.

44. Q209_2 Age Child 2.

45. Q209_3 Age Child 3.

46. Q209_4 Age Child 4.

47. Q209_5 Age Child 5,

48. Q209_6 Age Child 6.

49. Q209_7 Age Child 7.

50. Q209_8 Age Child 8.

51. Q209_9 Age Child 9.

52. Q209_10 Age Child 10.

53. Q209_11 Age Child 11.

54. Q209_12 Age Child 12.

55. Q209_13 Age Child 13.

56. Q209_14 Age Child 14.

57. Q209_15 Age Child 15.

58. Q216 What is the highest level of education you have completed or the highest degree you have received?
- NA
- Less than high school
- Some high school
- High school or equivalent (e.g., GED)
- Some college, but no degree
- College (e.g., B.A., B.S.)
- Some graduate school, but no degree
- Graduate school (e.g., M.S., M.D., Ph.D.)
- 6th Grade or earlier
- 7th Grade
- 8th Grade
- 9th Grade
- 10th Grade
- 11th Grade
- Less than secondary school (high school)
- Graduated from secondary school (high school)
- Trades certificate or diploma
- Certificate or diploma from community college, institute, CE
- Teaching certificate from provincial Dept. of Education
- Completed some university study, but no degree
- University certificate or diploma below bachelor level
- Bachelor's or first professional degree
- Grad or professional degree above bachelor level (e.g.
- Associate's degree
- Other
- Unknown

59. Q232 Which of the following income categories best describes your total household income after/before taxes?
- Unknown
- Less than $15,000
- $15,000 to $24,999
- $25,000 to $34,999
- $35,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $124,999
- $125,000 to $149,999
- $150,000 to $199,999
- $200,000 to $249,999
- $250,000 or more
- Less than 10,000 pounds
- 10,000 to 14,999 pounds
- 15,000 to 19,999 pounds

- 20,000 to 24,999 pounds
- 25,000 to 29,999 pounds
- 30,000 to 39,999 pounds
- 40,000 to 49,999 pounds
- 50,000 to 74,999 pounds
- 75,000 to 99,999 pounds
- 100,000 to 149,999 pounds
- 150,000 pounds or more
- Less than 10,000,000 lira
- 10,000,000 to 19,999,999 lira
- 20,000,000 to 29,999,999 lira
- 30,000,000 to 39,999,999 lira
- 40,000,000 to 49,999,999 lira
- 50,000,000 to 59,999,999 lira
- 60,000,000 to 79,999,999 lira
- 80,000,000 to 99,999,999 lira
- 100,000,000 to 149,999,999 lira
- 150,000,000 to 199,999,999 lira
- 200,000,000 lira or more
- Less than 1,000,000 pesetas
- 1,000,000 to 1,999,999 pesetas
- 2,000,000 to 2,999,999 pesetas
- 3,000,000 to 3,999,999 pesetas
- 4,000,000 to 4,999,999 pesetas
- 5,000,000 to 5,999,999 pesetas
- 6,000,000 to 6,999,999 pesetas
- 7,000,000 to 7,999,999 pesetas
- 8,000,000 to 8,999,999 pesetas
- 9,000,000 to 9,999,999 pesetas
- 10,000,000 or more pesetas
- Less than 20,000 deutsche marks
- 20,000 to 39,999 deutsche marks
- 40,000 to 59,999 deutsche marks
- 60,000 to 79,999 deutsche marks
- 80,000 to 99,999 deutsche marks
- 100,000 to 124,999 deutsche marks
- 125,000 to 149,999 deutsche marks
- 150,000 to 199,999 deutsche marks
- 200,000 to 299,999 deutsche marks
- 300,000 to 499,999 deutsche marks
- 500,000 or more deutsche marks
- Less than 50,000 French francs
- 50,000 to 99,999 French francs
- 100,000 to 149,999 French francs
- 150,000 to 199,999 French francs
- 200,000 to 249,999 French francs
- 250,000 to 299,999 French francs
- 300,000 to 399,999 French francs

- 400,000 to 499,999 French francs
- 500,000 to 749,999 French francs
- 750,000 to 999,999 French francs
- 1000,000 or more French francs
- Less than $15,000 (in Canadian dollars)
- $15,000 to $24,999 (in Canadian dollars)
- $25,000 to $34,999 (in Canadian dollars)
- $35,000 to $49,999 (in Canadian dollars)
- $50,000 to $74,999 (in Canadian dollars)
- $75,000 to $99,999 (in Canadian dollars)
- $100,000 to $124,999 (in Canadian dollars)
- $125,000 to $149,999 (in Canadian dollars)
- $150,000 to $199,999 (in Canadian dollars)
- $200,000 to $249,999 (in Canadian dollars)
- $250,000 or more (in Canadian dollars)
- Unknown
- Less than 10,000 yuan
- 10,000 to 19,999 yuan
- 20,000 to 29,999 yuan
- 30,000 to 39,999 yuan
- 40,000 to 49,999 yuan
- 50,000 to 59,999 yuan
- 60,000 to 79,999 yuan
- 80,000 to 99,999 yuan
- 100,000 to 124,999 yuan
- 125,000 to 149,999 yuan
- 150,000 or more yuan
- Less than 1,000,000 yen
- 1,000,000 to 1,499,999 yen
- 1,500,000 to 1,999,999 yen
- 2,000,000 to 2,999,999 yen
- 3,000,000 to 3,999,999 yen
- 4,000,000 to 4,999,999 yen
- 5,000,000 to 5,999,999 yen
- 6,000,000 to 6,999,999 yen
- 7,000,000 to 7,999,999 yen
- 8,000,000 to 9,999,999 yen
- 10,000,000 or more yen
- Less than 4,000 real
- 4,000 to 7,999 real
- 8,000 to 11,999 real
- 12,000 to 15,999 real
- 16,000 to 19,999 real
- 20,000 to 29,999 real
- 30,000 to 39,999 real
- 40,000 to 49,999 real
- 50,000 to 74,999 real
- 75,000 to 99,999 real

- 100,000 or more real
- Less than 50,000 Mexican pesos
- 50,000 to 74,999 Mexican pesos
- 75,000 to 99,999 Mexican pesos
- 100,000 to 149,999 Mexican pesos
- 150,000 to 199,999 Mexican pesos
- 200,000 to 249,999 Mexican pesos
- 250,000 to 299,999 Mexican pesos
- 300,000 to 399,999 Mexican pesos
- 400,000 to 499,999 Mexican pesos
- 500,000 to 999,999 Mexican pesos
- 1,000,000 Mexican pesos or more
- Less than $15,000 (in New Zealand dollars)
- $15,000 to $24,999 (in New Zealand dollars)
- $25,000 to $34,999 (in New Zealand dollars)
- $35,000 to $49,999 (in New Zealand dollars)
- $50,000 to $64,999 (in New Zealand dollars)
- $65,000 to $79,999 (in New Zealand dollars)
- $80,000 to $99,999 (in New Zealand dollars)
- $100,000 to $124,999 (in New Zealand dollars)
- $125,000 to $174,999 (in New Zealand dollars)
- $175,000 to $199,999 (in New Zealand dollars)
- $200,000 or more (in New Zealand dollars)
- Less than $20,000 (in Australian dollars)
- $20,000 to $29,999 (in Australian dollars)
- $30,000 to $39,999 (in Australian dollars)
- $40,000 to $49,999 (in Australian dollars)
- $50,000 to $74,999 (in Australian dollars)
- $75,000 to $99,999 (in Australian dollars)
- $100,000 to $124,999 (in Australian dollars)
- $125,000 to $149,999 (in Australian dollars)
- $150,000 to $199,999 (in Australian dollars)
- $200,000 to $299,999 (in Australian dollars)
- $300,000 or more (in Australian dollars)
- < &euro 5,000
- &euro 5,000 - &euro 9,999
- &euro 10,000 - &euro 19,999
- &euro 20,000 - &euro 29,999
- &euro 30,000 - &euro 39,999
- &euro 40,000 - &euro 49,999
- &euro 50,000 - &euro 74,999
- &euro 75,000 - &euro 99,999
- &euro 100,000 - &euro 149,999
- &euro 150,000 - &euro 200,000
- &euro 200,000
- Decline to answer
- Unknown

60. Q60 Status of respondent.
- NA
- Qualified Respondent, Quota Not Met
- Partially Qualified Respondent, Quota Not Met
- Qualified Respondent, Quota Met
- Partially Qualified Respondent, Quota Met
- Overall Quota Met
- Not Qualified

Appendix C – American Red Cross Survey Questions, FKDS-Full Katrina Data Set

Next, and in detail, are the questions related to response operation made by the American Red Cross to clients of the Katrina and Rita Hurricane in August, 2005 and enclosed information connected to client's zip code, city relocations, and clients' feelings after the outage and during each response stage, difficult experiences, and lived situations in shelters, among others.

1. Center.

2. City of Origin.

3. State of Origin.

4. Zip Code of Origin.

5. City Residing in Now.

6. State Residing in Now.

7. New Orleans resident before Hurricane.
   - Yes
   - No

8. Classification according to FEMA.
   - New Orleans city
   - Western NO suburbs
   - Eastern MSA/North of Lake Ponchatrain
   - Severe damage outside greater NO
   - Surrounding FEMA area
   - Others

9. Gender-respondent.
   - Male
   - Female

10. Emotional Feelings at time of Hurricane: First Response.
    - Other
    - DK
    - REF
    - None
    - All
    - Afraid
    - Aggravated
    - Emotional/All kinds of emotions
    - Feeling better now/All right

- Anger
- Anxiety/Anxiousness
- Apprehension
- Bad
- Blessed
- Concerned
- Confused
- Crying
- Depressed
- Devastated
- Disbelief
- Disgusted
- Fear
- Frustrated
- Grateful
- Happy
- Helplessness
- Hopeful/Hope
- Horrible
- Hurt
- Feelings of loss
- Lost/Do not know where to turn
- Nervous
- Overwhelmed
- Relieved/relief
- Sad
- Scared/Scary
- Shock/Shocked
- Stressed/stressed out
- Terrified
- Thankful
- Tired
- Unbelievable
- Uncertainty
- Upset
- Emotional
- Worried
- Displaced
- Distraught
- Distressed
- Homesick
- Surprised
- Terrible
- Calm
- Homeless
- Lucky/fortunate
- Not Answer

11. Emotional Feelings at time of Hurricane: Second Response.

- Other
- DK
- REF
- None
- All
- Afraid
- Aggravated
- Emotional/All kinds of emotions
- Feeling better now/All right
- Anger
- Anxiety/Anxiousness
- Apprehension
- Bad
- Blessed
- Concerned
- Confused
- Crying
- Depressed
- Devastated
- Disbelief
- Disgusted
- Fear
- Frustrated
- Grateful
- Happy
- Helplessness
- Hopeful/Hope
- Horrible
- Hurt
- Feelings of loss
- Lost/Do not know where to turn
- Nervous
- Overwhelmed
- Relieved/relief
- Sad
- Scared/Scary
- Shock/Shocked
- Stressed/stressed out
- Terrified
- Thankful
- Tired
- Unbelievable
- Uncertainty
- Upset
- Emotional
- Worried
- Displaced

- Distraught
- Distressed
- Homesick
- Surprised
- Terrible
- Calm
- Homeless
- Lucky/fortunate
- Not Answer

12. Emotional Feelings at time of Hurricane: Third Response.
    - Other
    - DK
    - REF
    - None
    - All
    - Afraid
    - Aggravated
    - Emotional/All kinds of emotions
    - Feeling better now/All right
    - Anger
    - Anxiety/Anxiousness
    - Apprehension
    - Bad
    - Blessed
    - Concerned
    - Confused
    - Crying
    - Depressed
    - Devastated
    - Disbelief
    - Disgusted
    - Fear
    - Frustrated
    - Grateful
    - Happy
    - Helplessness
    - Hopeful/Hope
    - Horrible
    - Hurt
    - Feelings of loss
    - Lost/Do not know where to turn
    - Nervous
    - Overwhelmed
    - Relieved/relief
    - Sad
    - Scared/Scary
    - Shock/Shocked

- Stressed/stressed out
- Terrified
- Thankful
- Tired
- Unbelievable
- Uncertainty
- Upset
- Emotional
- Worried
- Displaced
- Distraught
- Distressed
- Homesick
- Surprised
- Terrible
- Calm
- Homeless
- Lucky/fortunate
- Not Answer

13. Emotional Feelings Now: First Response.
    - Other
    - DK
    - REF
    - None
    - All
    - Afraid
    - Aggravated
    - Emotional/All kinds of emotions
    - Feeling better now/All right
    - Anger
    - Anxiety/Anxiousness
    - Apprehension
    - Bad
    - Blessed
    - Concerned
    - Confused
    - Crying
    - Depressed
    - Devastated
    - Disbelief
    - Disgusted
    - Fear
    - Frustrated
    - Grateful
    - Happy
    - Helplessness
    - Hopeful/Hope

- Horrible
- Hurt
- Feelings of loss
- Lost/Do not know where to turn
- Nervous
- Overwhelmed
- Relieved/relief
- Sad
- Scared/Scary
- Shock/Shocked
- Stressed/stressed out
- Terrified
- Thankful
- Tired
- Unbelievable
- Uncertainty
- Upset
- Emotional
- Worried
- Displaced
- Distraught
- Distressed
- Homesick
- Surprised
- Terrible
- Calm
- Homeless
- Lucky/fortunate
- Not Answer

14. Emotional Feelings Now: Second Response.
    - Other
    - DK
    - REF
    - None
    - All
    - Afraid
    - Aggravated
    - Emotional/All kinds of emotions
    - Feeling better now/All right
    - Anger
    - Anxiety/Anxiousness
    - Apprehension
    - Bad
    - Blessed
    - Concerned
    - Confused
    - Crying

- Depressed
- Devastated
- Disbelief
- Disgusted
- Fear
- Frustrated
- Grateful
- Happy
- Helplessness
- Hopeful/Hope
- Horrible
- Hurt
- Feelings of loss
- Lost/Do not know where to turn
- Nervous
- Overwhelmed
- Relieved/relief
- Sad
- Scared/Scary
- Shock/Shocked
- Stressed/stressed out
- Terrified
- Thankful
- Tired
- Unbelievable
- Uncertainty
- Upset
- Emotional
- Worried
- Displaced
- Distraught
- Distressed
- Homesick
- Surprised
- Terrible
- Calm
- Homeless
- Lucky/fortunate
- Not Answer

15. Emotional Feelings Now: Third Response.
    - Other
    - DK
    - REF
    - None
    - All
    - Afraid
    - Aggravated

- Emotional/All kinds of emotions
- Feeling better now/All right
- Anger
- Anxiety/Anxiousness
- Apprehension
- Bad
- Blessed
- Concerned
- Confused
- Crying
- Depressed
- Devastated
- Disbelief
- Disgusted
- Fear
- Frustrated
- Grateful
- Happy
- Helplessness
- Hopeful/Hope
- Horrible
- Hurt
- Feelings of loss
- Lost/Do not know where to turn
- Nervous
- Overwhelmed
- Relieved/relief
- Sad
- Scared/Scary
- Shock/Shocked
- Stressed/stressed out
- Terrified
- Thankful
- Tired
- Unbelievable
- Uncertainty
- Upset
- Emotional
- Worried
- Displaced
- Distraught
- Distressed
- Homesick
- Surprised
- Terrible
- Calm
- Homeless
- Lucky/fortunate

- Not Answer

16. What Has Helped Get You Through This Time: First Response?
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Volunteers from church
    - Family
    - Faith/spirituality/worship/Jesus/God
    - Friends
    - Red Cross
    - Praying/Prayer
    - Talking with others
    - Various organizations
    - Community/Neighbors
    - Job/co-workers
    - Insurance
    - Food stamps
    - Keeping busy/Getting back to daily routine
    - Not Answer

17. What Has Helped Get You Through This Time: Second Response?
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Volunteers from church
    - Family
    - Faith/spirituality/worship/Jesus/God
    - Friends
    - Red Cross
    - Praying/Prayer
    - Talking with others
    - Various organizations
    - Community/Neighbors
    - Job/co-workers
    - Insurance
    - Food stamps
    - Keeping busy/Getting back to daily routine
    - Not Answer

18. What Has Helped Get You Through This Time: Third Response?
    - Other

- DK
- REF
- None
- All
- FEMA
- Volunteers from church
- Family
- Faith/spirituality/worship/Jesus/God
- Friends
- Red Cross
- Praying/Prayer
- Talking with others
- Various organizations
- Community/Neighbors
- Job/co-workers
- Insurance
- Food stamps
- Keeping busy/Getting back to daily routine
- Not Answer

19. What Has Been Most Difficult for You: First Response?
    - Other
    - DK
    - REF
    - None
    - All
    - Not having electricity/running water
    - Losing everything we owned
    - No longer having a job
    - Having to ask for assistance/Not getting help
    - Being separated from family/friends
    - Not knowing condition of home
    - Dealing with the damage/Getting things repaired, replaced
    - Not having food
    - Financial difficulty/strain of paying debts
    - Trying to find a place to live
    - Getting our lives back on track/back to normal
    - Transportation/Traffic jams
    - Price/availability of gas
    - Death of loved ones
    - Mental/emotional state
    - Starting over/Adjusting to new start
    - Health/Healthcare issues
    - Dealing with insurance/paper work
    - Schooling issues
    - Want to help more/others are worse off/Feel bad for them
    - Living arrangements/Overcrowded
    - Availability of businesses/services

- Not Answer

20. What Has Been Most Difficult for You: Second Response?
    - Other
    - DK
    - REF
    - None
    - All
    - Not having electricity/running water
    - Losing everything we owned
    - No longer having a job
    - Having to ask for assistance/Not getting help
    - Being separated from family/friends
    - Not knowing condition of home
    - Dealing with the damage/Getting things repaired, replaced
    - Not having food
    - Financial difficulty/strain of paying debts
    - Trying to find a place to live
    - Getting our lives back on track/back to normal
    - Transportation/Traffic jams
    - Price/availability of gas
    - Death of loved ones
    - Mental/emotional state
    - Starting over/Adjusting to new start
    - Health/Healthcare issues
    - Dealing with insurance/paper work
    - Schooling issues
    - Want to help more/others are worse off/Feel bad for them
    - Living arrangements/Overcrowded
    - Availability of businesses/services
    - Not Answer

21. What Has Been Most Difficult for You: Third Response?
    - Other
    - DK
    - REF
    - None
    - All
    - Not having electricity/running water
    - Losing everything we owned
    - No longer having a job
    - Having to ask for assistance/Not getting help
    - Being separated from family/friends
    - Not knowing condition of home
    - Dealing with the damage/Getting things repaired, replaced
    - Not having food
    - Financial difficulty/strain of paying debts
    - Trying to find a place to live

- Getting our lives back on track/back to normal
- Transportation/Traffic jams
- Price/availability of gas
- Death of loved ones
- Mental/emotional state
- Starting over/Adjusting to new start
- Health/Healthcare issues
- Dealing with insurance/paper work
- Schooling issues
- Want to help more/others are worse off/Feel bad for them
- Living arrangements/Overcrowded
- Availability of businesses/services
- Not Answer

22. Happened to You: Went without Food for at Least a Day.
    - Yes, happened
    - No, did not happen
    - DK
    - REF

23. Happened to You: Went without Drinking Water for at Least a Day.
    - Yes, happened
    - No, did not happen
    - DK
    - REF

24. Happened to You: Spent at Least One Night in an Emergency Shelter.
    - Yes, happened
    - No, did not happen
    - DK
    - REF

25. Happened to You: Separated from Family Members for at Least a Day.
    - Yes, happened
    - No, did not happen
    - DK
    - REF

26. Happened to You: Physically Injured or Hurt.
    - Yes, happened
    - No, did not happen
    - DK
    - REF

27. Happened to You: Had a Vehicle Damaged.
    - Yes, happened
    - No, did not happen
    - DK
    - REF

28. Happened to You: Lost a Pet.
- Yes, happened
- No, did not happen
- DK
- REF

29. Happened to You: Feared for Your Life.
- Yes, happened
- No, did not happen
- DK
- REF

30. Happened to You: Were a Victim of a Crime.
- Yes, happened
- No, did not happen
- DK
- REF

31. Happened to You: Worried about Elderly Family Members Living in Path of Hurricane.
- Yes, happened
- No, did not happen
- DK
- REF

32. Been Reunited with all Family Members.
- Reunited with all
- Still separated from some
- Family member died (VOL)
- DK
- REF

33. Know Where Separated Family Members Are.
- Know where they are
- Still unsure
- Family member died (VOL)
- DK
- REF

34. Children Under 18.
- Yes
- No
- DK
- REF

35. Separated from Children at Any Time.
- Yes, was separated
- No, not

- Child died (VOL)
- DK
- REF

36. Been Reunited with all Children.
    - Reunited with all
    - Still separated
    - Child died (VOL)
    - DK
    - REF

37. To What Extent Have Trouble Sleeping.
    - A great deal
    - Quite a bit
    - Some
    - Very little
    - None
    - DK
    - REF

38. To What Extent Have Feelings of Anxiety.
    - A great deal
    - Quite a bit
    - Some
    - Very little
    - None
    - DK
    - REF

39. To What Extent Have Feelings of Depression.
    - A great deal
    - Quite a bit
    - Some
    - Very little
    - None
    - DK
    - REF

40. Evacuate House or Apartment Due to Hurricane Katrina.
    - Yes, before
    - Yes, after
    - Yes, during (VOL)
    - No, did not
    - DK
    - REF

41. Why Did You Not Evacuate: First Mention.
    - Other
    - DK

- REF
- None
- All
- Thought we were far enough away from coast
- Stubborn/Hard headed/Did not want to leave
- Could not afford to leave
- Keeping family together
- Put destiny/faith in God
- Had no place to go
- Did not think it would be bad/Previous hurricanes not as bad
- Had no transportation/unreliable transportation
- Had to stay and protect property
- Thought house structure was sound/could withstand it
- Waited until last minute and it was too late
- Availability of gas/afraid would be stuck in traffic without
- Poor health/Could not leave due to medical reasons
- Had to work
- Not Answer

42. Why Did You Not Evacuate: Second Mention.
    - Other
    - DK
    - REF
    - None
    - All
    - Thought we were far enough away from coast
    - Stubborn/Hard headed/Did not want to leave
    - Could not afford to leave
    - Keeping family together
    - Put destiny/faith in God
    - Had no place to go
    - Did not think it would be bad/Previous hurricanes not as bad
    - Had no transportation/unreliable transportation
    - Had to stay and protect property
    - Thought house structure was sound/could withstand it
    - Waited until last minute and it was too late
    - Availability of gas/afraid would be stuck in traffic without
    - Poor health/Could not leave due to medical reasons
    - Had to work
    - Not Answer

43. Why Did You Not Evacuate: Third Mention.
    - Other
    - DK
    - REF
    - None
    - All
    - Thought we were far enough away from coast

- Stubborn/Hard headed/Did not want to leave
- Could not afford to leave
- Keeping family together
- Put destiny/faith in God
- Had no place to go
- Did not think it would be bad/Previous hurricanes not as bad
- Had no transportation/unreliable transportation
- Had to stay and protect property
- Thought house structure was sound/could withstand it
- Waited until last minute and it was too late
- Availability of gas/afraid would be stuck in traffic without
- Poor health/Could not leave due to medical reasons
- Had to work
- Not Answer

44. Condition of House or Apartment Living in Before Hurricane Katrina Hit.
    - Completely destroyed
    - Damaged so badly you cannot live in it
    - Damaged, can still live in it
    - Not damaged
    - Unaware of condition
    - DK
    - REF

45. Own/Rent House or Apartment.
    - Other
    - DK
    - REF
    - Live with parents (VOL)
    - Own
    - Rent

46. Likelihood Community Will Be Hit by Another Disaster as Bad as Katrina.
    - Very likely
    - Somewhat likely
    - Not too likely
    - Not likely at all
    - DK
    - REF

47. Where Are You Currently Living?
    - Somewhere else
    - DK
    - REF
    - Same home as before hurricane
    - Someone else’s home
    - Emergency shelter
    - Hotel or motel

- Apartment or house rented after hurricane
- Trailer/Mobile home

48. Living in Home of Relative, Friend or Someone Else.
    - Relative
    - Friend
    - Someone you did not know
    - DK
    - REF

49. Have a Job Before Hurricane Katrina Hit.
    - Yes
    - No
    - DK
    - REF

50. Description of Current Employment Situation.
    - Working in same job
    - Working in new job, just as good as old job
    - Working in new job, not as good as old one
    - Not working
    - DK
    - REF

51. How Worried about What Will Happen to You in Next Few Months.
    - Very worried
    - Somewhat worried
    - Not too worried
    - Not worried at all
    - DK
    - REF

52. How Worried about What Will Happen to You in Next Five Years.
    - Very worried
    - Somewhat worried
    - Not too worried
    - Not worried at all
    - DK
    - REF

53. Plans for the Future.
    - Will definitely return
    - Will probably return
    - Will probably not return
    - Will definitely not return
    - Already returned (VOL)
    - DK
    - REF

54. Type of Assistance Most Need: First Response.
- Other
- DK
- REF
- None
- All
- Car/transportation
- House/apartment/place to stay
- Job/employment/help with business
- Financial help/money/cash
- Household goods/furniture/dishes
- Food/water/ice
- Clothes
- Counseling/emotional help
- Needed more help from FEMA
- Help with damage to home/property/contractors
- Prayer
- Need insurance to help more
- Medical assistance/medicine
- Not Answer

55. Type of Assistance Most Need: Second Response.
- Other
- DK
- REF
- None
- All
- Car/transportation
- House/apartment/place to stay
- Job/employment/help with business
- Financial help/money/cash
- Household goods/furniture/dishes
- Food/water/ice
- Clothes
- Counseling/emotional help
- Needed more help from FEMA
- Help with damage to home/property/contractors
- Prayer
- Need insurance to help more
- Medical assistance/medicine
- Not Answer

56. Type of Assistance Most Need: Third Response.
- Other
- DK
- REF
- None
- All

- Car/transportation
- House/apartment/place to stay
- Job/employment/help with business
- Financial help/money/cash
- Household goods/furniture/dishes
- Food/water/ice
- Clothes
- Counseling/emotional help
- Needed more help from FEMA
- Help with damage to home/property/contractors
- Prayer
- Need insurance to help more
- Medical assistance/medicine
- Not Answer

57. What Government Agencies Been Most Helpful: First Response.
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Federal government (non-specific)
    - Dept of Health and Human Services
    - Housing authority
    - Assisted living
    - Local government agencies
    - National Guard/Military
    - State government agencies
    - Sheriffs Department
    - Food stamps
    - Unemployment/Dept of Labor
    - City offices
    - Not Answer

58. What Government Agencies Been Most Helpful: Second Response.
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Federal government (non-specific)
    - Dept of Health and Human Services
    - Housing authority
    - Assisted living
    - Local government agencies
    - National Guard/Military

- State government agencies
- Sheriffs Department
- Food stamps
- Unemployment/Dept of Labor
- City offices
- Not Answer

59. What Government Agencies Been Most Helpful: Third Response.
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Federal government (non-specific)
    - Dept of Health and Human Services
    - Housing authority
    - Assisted living
    - Local government agencies
    - National Guard/Military
    - State government agencies
    - Sheriffs Department
    - Food stamps
    - Unemployment/Dept of Labor
    - City offices
    - Not Answer

60. What Government Agencies Least Satisfied With: First Response.
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Federal government (non-specific)
    - Dept of Health and Human Services
    - Housing authority
    - Assisted living
    - Local government agencies
    - National Guard/Military
    - State government agencies
    - Sheriffs Department
    - Food stamps
    - Unemployment/Dept of Labor
    - City offices
    - Not Answer

61. What Government Agencies Least Satisfied With: Second Response.

- Other
- DK
- REF
- None
- All
- FEMA
- Federal government (non-specific)
- Dept of Health and Human Services
- Housing authority
- Assisted living
- Local government agencies
- National Guard/Military
- State government agencies
- Sheriffs Department
- Food stamps
- Unemployment/Dept of Labor
- City offices
- Not Answer

62. What Government Agencies Least Satisfied With: Third Response.
    - Other
    - DK
    - REF
    - None
    - All
    - FEMA
    - Federal government (non-specific)
    - Dept of Health and Human Services
    - Housing authority
    - Assisted living
    - Local government agencies
    - National Guard/Military
    - State government agencies
    - Sheriffs Department
    - Food stamps
    - Unemployment/Dept of Labor
    - City offices
    - Not Answer

63. Job Federal Government Doing in Dealing with Hurricane and Aftermath.
    - Excellent
    - Good
    - Only fair
    - Poor
    - DK
    - REF

64. Job State Government Doing in Dealing with Hurricane and Aftermath.

- Excellent
- Good
- Only fair
- Poor
- DK
- REF

65. Job Mayor/Local Officials Doing in Dealing with Hurricane and Aftermath.
    - Excellent
    - Good
    - Only fair
    - Poor
    - DK
    - REF

66. Receive from Red Cross: Stay in Shelter.
    - Yes
    - No
    - DK
    - REF

67. Receive from Red Cross: Food.
    - Yes
    - No
    - DK
    - REF

68. Receive from Red Cross: Hotel Stay.
    - Yes
    - No
    - DK
    - REF

69. Receive from Red Cross: Financial Assistance.
    - Yes
    - No
    - DK
    - REF

70. Receive from Red Cross: Mental Health Assistance.
    - Yes
    - No
    - DK
    - REF

71. Receive from Red Cross: Anything Else.
    - Yes
    - No
    - DK

- REF

72. Rate Red Cross: Giving You Right Information Before Applying.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF

73. Rate Red Cross: Making It Easy for You to Apply for Help.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF
    -

74. Rate Red Cross: Meeting Your Most Serious Needs.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF

75. Rate Red Cross: Giving You Help that is Useful in Beginning Your Recovery.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF

76. Rate Red Cross: Giving You Timely Assistance.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF

77. Rate Red Cross: Treating You with Kindness, Respect and Fairness.
    - Excellent

- Very good
- Good
- Fair
- Poor
- DK
- REF

78. Rating of Stay in Shelter.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF

79. Rating of Red Cross Overall.
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
    - DK
    - REF

80. Why Rate Red Cross Fair/Poor: First Response.
    - Other
    - DK
    - REF
    - None
    - All
    - Not enough assistance/Assistance was not fair
    - Could not get through to operator/on hold
    - Could not get correct answers/information
    - Red Cross not prepared for disaster of this size
    - Need more knowledgeable/helpful staff
    - Unorganized/Inconsistent
    - Took too long
    - Needed better information on how to get assistance
    - Availability/Need more locations/shorter lines
    - Need more staff
    - Have not received any help at all
    - Have been helpful

81. Why Rate Red Cross Fair/Poor: Second Response.
    - Other
    - DK
    - REF

- None
- All
- Not enough assistance/Assistance was not fair
- Could not get through to operator/on hold
- Could not get correct answers/information
- Red Cross not prepared for disaster of this size
- Need more knowledgeable/helpful staff
- Unorganized/Inconsistent
- Took too long
- Needed better information on how to get assistance
- Availability/Need more locations/shorter lines
- Need more staff
- Have not received any help at all
- Have been helpful
- Not Answer

82. Age

83. Hispanic?
    - Yes
    - No
    - Dk
    - Ref

84. What race?
    - Other
    - DK
    - REF
    - None
    - White
    - African-American
    - Hispanic
    - Asian
    - American Indian/Native American

85. Follow-up: White, Black hispanic?
    - Other
    - DK
    - REF
    - White Hispanic
    - Black Hispanic
    - Hispanic--refuses to discriminate

86. Income
    - Less than $10K
    - $10-$20K
    - $20-$30K
    - $30-$40K

- $40K-$50K
- $50-$75K
- $75K-$99k
- $100K and over
- Dk
- Ref

87. Zipcode

88. Names for USAT.
    - Yes
    - No
    - REF

89. Calling area AT&T.

90. Calling minutes.

91. Study code.

92. ID person who attend.

93. Gender-interviewer.
    - Male
    - Female

94. Red Cross center.
    - Lincoln 68
    - Lincoln DT
    - Omaha
    - Houston
    - Farnam (Omaha)
    - Atlanta
    - Irvine
    - Atlanta
    - Houston
    - Greentree

95. Race person who attend.
    - Other
    - DK
    - REF
    - White
    - Black
    - Asian/Pacific Islander
    - American Indian/Alaska Native

96. System code.

97. Data code.

98. Age Recoded.
- 18-29
- 30-49
- 50-64
- 65+

99. Income Recoded.
- Less than $20k
- $20K-Less than $30K
- $30K-Less than $50K
- $50K-Less than $75K
- $75K and above

100. Race as in Banners in Crosstabs.
- Non-Hispanic White
- Non-white

101. Detailed Banner on Race.
- Non-Hispanic White
- Non-Hispanic Black
- White Hispanic
- Black Hispanic
- Hispanic, refuse to discriminate
- Asian
- Other or DK
- REF

102. Sex/Age
- Male, 18-49
- Male, 50+
- Female, 18-49
- Female, 50+
- Not Answer

103. Sex/Race
- White Male
- White Female
- Black Male
- Black Female
- Other

104. Recoded: Separated from Family.
- Never separated
- Separated, now reunited with all
- Still separated, know where they are
- Still separated, unsure of where they are
- No opinion

105. Recoded: Separated from Children.
- No children
- Never separated
- Separated, now reunited with all
- Still separated
- No opinion

106. Evacuate Home Due to Hurricane.
- Yes
- No
- DK
- REF

107. Job Status.
- Working in same job
- Working in new job, just as good as old job
- Working in new job, not as good as old job
- Not working now, were before hurricane
- Not working before hurricane
- DK
- REF

Appendix D – Predictors Extracted from FKDS-Full Katrina Data Set

The results of the analysis of Full Katrina Data Set reveal that:

1. Owning or renting a house or apartment had an impact on house or apartment evacuation due to Hurricane Katrina. Clients who owned a house or apartment, had a likelihood of 68.40% of evacuating their house or apartment before Hurricane Katrina. For those who owned a house or apartment, income was crucial. Those who owned a house or apartment, and had an income less than $10,000, had a likelihood of 52.86% of evacuating their house or apartment before Hurricane Katrina. In addition, those who owned a house or apartment, and had an income more than $10,000, had a likelihood of 70.49% of evacuating their house or apartment before Hurricane Katrina.

   Clients, who rented a house or apartment, had a likelihood of 65.08% of evacuating their house or apartment before Hurricane Katrina. For those who rented a house or apartment, income was crucial. Those who rented a house or apartment, and had an income less than $10,000, had a likelihood of 58.09% of evacuating their house or apartment before Hurricane Katrina. In addition, those who rented a house or apartment, and had an income less than $10,000 or between $30,000 and $40,000, had a likelihood of 66.20% of evacuating their house or apartment before Hurricane Katrina. For those who rented a house or apartment, and had an income less than $10,000 or between $30,000 and $40,000, race was crucial. Those who rented a house or apartment, and had an income less than $10,000 or between $30,000 and $40,000 and were Non-Hispanic white had a likelihood of 71.74% of evacuating their house or apartment before Hurricane Katrina. Those who rented a house or apartment, and had an income less than $10,000 or between $30,000 and $40,000 and were Non-white had a likelihood of 64.26% of evacuating their house or apartment before Hurricane Katrina. Finally, those who rented a house or apartment, and had an income more than $40,000, had a likelihood of 81.08% of evacuating their house or apartment before Hurricane Katrina.

   Those who live with parents had a likelihood of 76.47% of evacuating house or apartment before Hurricane Katrina (see Figure D-1).

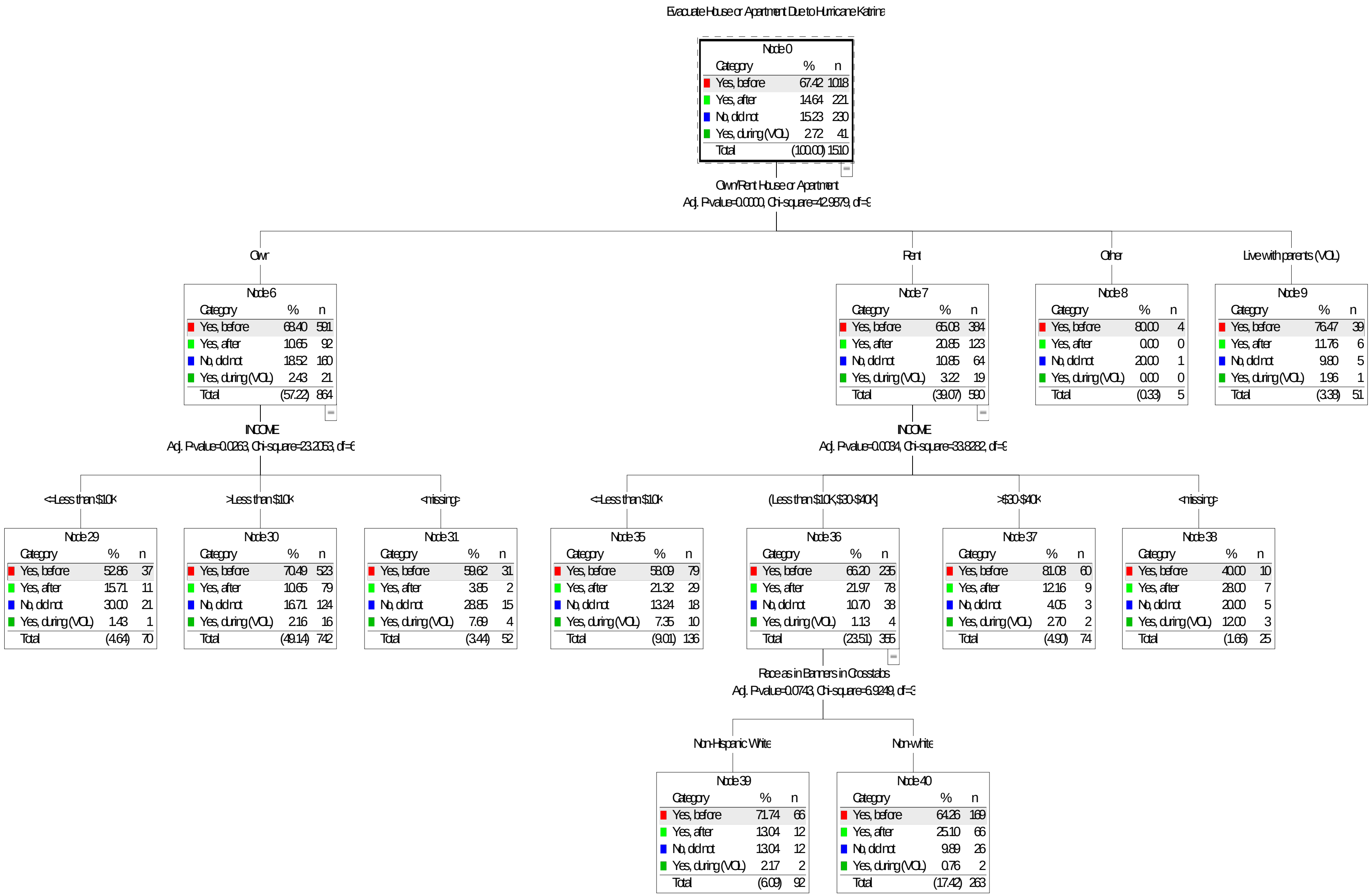


Figure D-1. Predictor for: “Evacuate House or Apartment Due to Hurricane Katrina”. Author’s Elaboration, 2008.

2. Evacuating a house or apartment due to Hurricane Katrina, had an impact on: spent at least one night in an emergency shelter. Clients, who evacuated their house or apartment before Hurricane Katrina, had a likelihood of 24.85% of spending at least one night in an emergency shelter. Those who evacuated their house or apartment after Hurricane Katrina had a likelihood of 42.99% of spending at least one night in an emergency shelter. Those who evacuated their house or apartment during Hurricane Katrina had a likelihood of 39.02% of spending at least one night in an emergency shelter. Those who did not evacuated their house or apartment due to Hurricane Katrina, had a likelihood of 7.39% of spending at least one night in an emergency shelter (see Figure D-2).

3. Receiving financial assistance from Red Cross, had an impact on: rate Red Cross on meeting clients' most serious needs. Clients, who received financial assistance, had a likelihood of 39.30% of rate Red Cross as excellent on meeting clients' most serious needs. For those who received financial assistance, received mental health assistance was crucial. Those who received financial assistance, and received mental health assistance, had a likelihood of 52.97% of rate Red Cross as excellent on meeting clients' most serious needs. In addition, those who received financial assistance, and did not receive mental health assistance, had a likelihood of 37.15% of rate Red Cross as excellent on meeting clients' most serious needs. For those who received financial assistance, and did not receive mental health assistance, received food was crucial. Those who received financial assistance, and did not receive mental health assistance and received food, had a likelihood of 42.53% of rate Red Cross as excellent on meeting clients' most serious needs. Those who received financial assistance, and did not receive mental health assistance and did not receive food, had a likelihood of 34.47% of rate Red Cross as excellent on meeting clients' most serious needs.

   Clients, who did not receive financial assistance, had a likelihood of 21.48% of rate Red Cross as excellent on meeting clients' most serious needs. For those who did not receive financial assistance, received food was crucial. Those who did not receive financial assistance, and received food, had a likelihood of 39.66% of rate Red Cross as excellent on meeting clients' most serious needs. Finally, those who did not receive financial assistance, and did not receive food, had a likelihood of 9.09% of rate Red Cross as excellent on meeting clients' most serious needs (see Figure D-3).

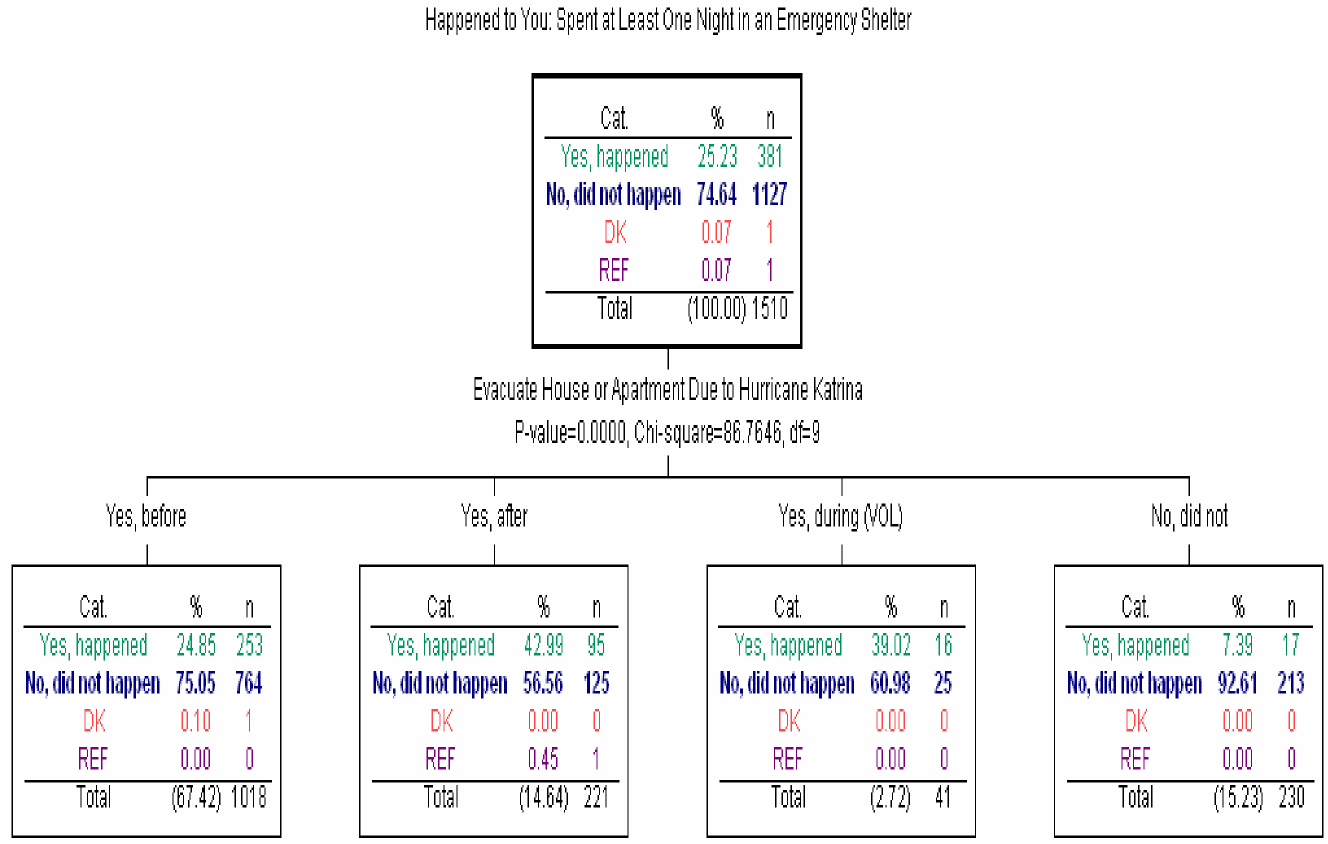


Figure D-2. Predictor for: "Spent at Least One Night in an Emergency Shelter". Author's Elaboration, 2008.

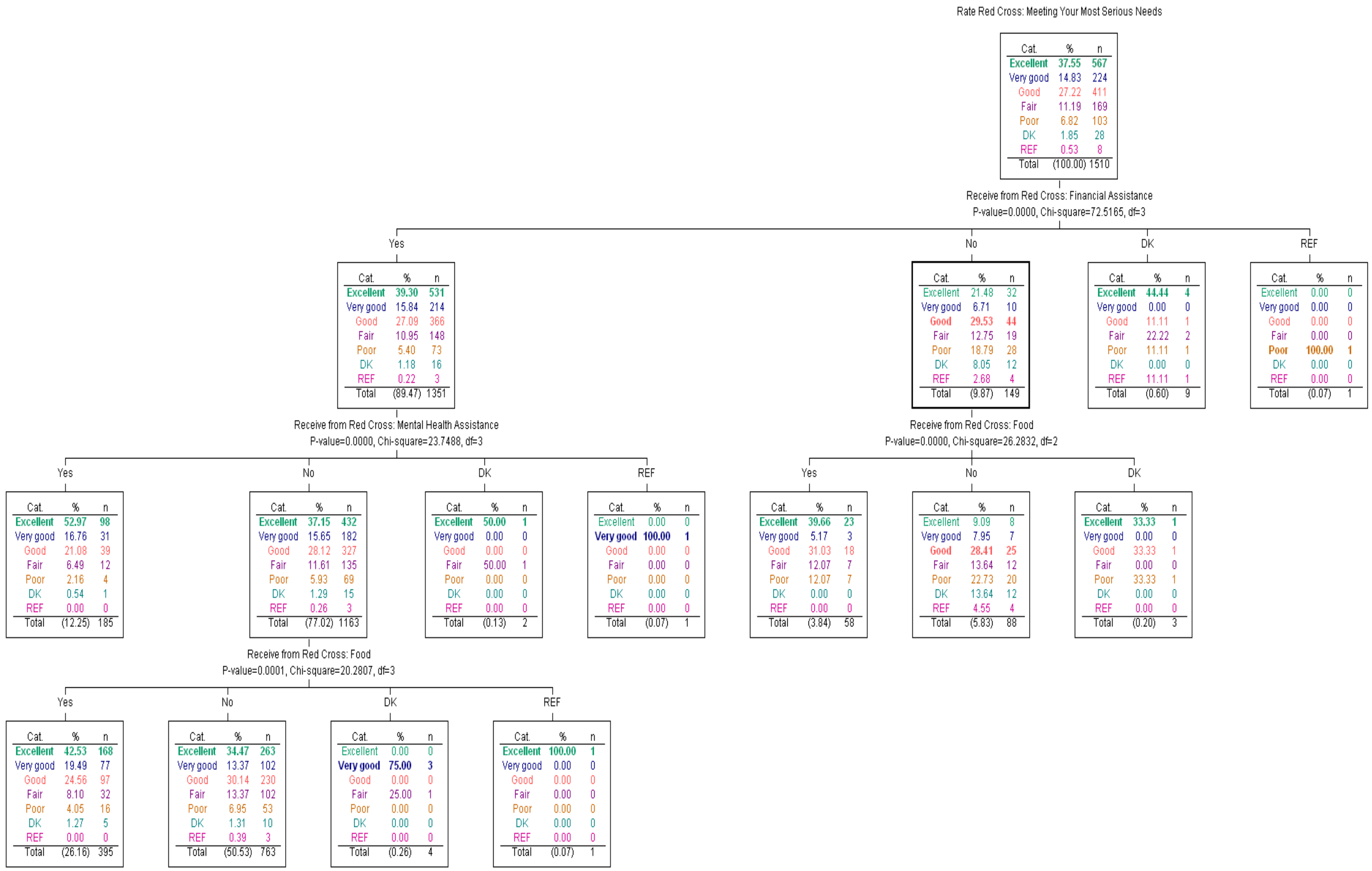


Figure D-3. Predictor for: "Rate Red Cross Meeting Most Serious Needs". Author's Elaboration, 2008.

Appendix E – Descriptive Statistics Extracted from KPD- Katrina Panel Data

Table E-1. Number of days Trapped in Home. Author's Elaboration, 2008.

Statistics

14. For how many days were you trapped in your home?

N	Valid	207
	Missing	473
Mean		8.86
Median		3.00
Mode		2
Std. Deviation		22.948

In this table the number of cases N is split in Valid and Missing cases.

In this table the mean, median and mode of number of days trapped in home are in close disagreement.

14. For how many days were you trapped in your home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	34	5.0	16.4	16.4
	2	58	8.5	28.0	44.4
	3	51	7.5	24.6	69.1
	4	28	4.1	13.5	82.6
	5	10	1.5	4.8	87.4
	6	1	.1	.5	87.9
	7	8	1.2	3.9	91.8
	8	1	.1	.5	92.3
	11	1	.1	.5	92.8
	14	2	.3	1.0	93.7
	Less than one day	13	1.9	6.3	100.0
	Total	207	30.4	100.0	
Missing	No Answer	3	.4		
	System	470	69.1		
	Total	473	69.6		
Total		680	100.0		

In the frequency table "For how many days were you trapped in home" the variable is split into these possible answers (From 1 to 14, less than one day), and their absolute (Frequency) and the relative (Percent) frequencies are shown, as well as the percentage and cumulative percentage of valid cases (Valid Percent and Cumulative Percent).

The percent calculates the relative frequencies, including the missing cases. On the other hand, Valid Percent calculates the relative frequencies excluding the missing cases, so that the relative frequencies of the valid cases count up to 100%.

Examination of the frequency table for the number of days trapped in a home confirms that the highest frequency of scores was 2 (58 clients, or 8.5%, received this score), and the Cumulative Percent column shows that 44.4% of clients received a score of 2 or lower (and 55.6% scored 3 or higher). Therefore, clients' highest frequency of being trapped in a home before going to a shelter, was 2 days.

For the modeling programming purpose 14 days was chosen as the delay for those people who decided not to evacuate their homes.

Appendix F – Equation Definition

Stella Equations

Affected Community
People_in_Shelter(t) = People_in_Shelter(t - dt) + (Shelter_Incoming_Rate - Shelter_Leaving_Rate) * dtINIT People_in_Shelter = 10 {person}
UNITS: person
INFLOWS:
Shelter_Incoming_Rate = INT(Shelter_Opening_Rate*Shelter_Limit) {person/day}
UNITS: person/day
OUTFLOWS:
Shelter_Leaving_Rate = SMTH1(INT(Cases_Opening_Rate*Number_of_Family_Group's_People_per_Case),2) {person/day}
UNITS: person/day
People_Requiring_Shelter(t) = People_Requiring_Shelter(t - dt) + (Total_Leaving_Rate_to_Shelter_Before_Hurricane + Total_Leaving_Rate_to_Shelter_After_Hurricane + Total_Leaving_Rate_to_Shelter_During_Hurricane + Total_Leaving_Rate_to_Shelter_Not_Evacuated_Population - Shelter_Incoming_Rate) * dtINIT People_Requiring_Shelter = 0 {person}
UNITS: person
INFLOWS:
Total_Leaving_Rate_to_Shelter_Before_Hurricane = INT((Total_Evacuated_Population_Before_Hurricane*Before_Fraction)/Before_Evacuation_Delay_Duration) {person/day}
UNITS: person/day
Total_Leaving_Rate_to_Shelter_After_Hurricane = INT(Total_Evacuated_Population_After_Hurricane*After_Fraction)/After_Evacuation_Delay_Duration {person/day}
UNITS: person/day
Total_Leaving_Rate_to_Shelter_During_Hurricane = INT(Total_Evacuated_Population_During_Hurricane*During_Fraction)/During_Evacuation_Delay_Duration {person/day}
UNITS: person/day
Total_Leaving_Rate_to_Shelter_Not_Evacuated_Population = INT(Total_Not_Evacuated_Population*Not_Fraction)/Not_Evacuation_Delay_Duration {person/day}
UNITS: person/day
OUTFLOWS:
Shelter_Incoming_Rate = INT(Shelter_Opening_Rate*Shelter_Limit) {person/day}
UNITS: person/day

Population_Affected_Type_1(t) = Population_Affected_Type_1(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_1 - Incoming_Rate_After_Hurricane_Type_1 - Incoming_Rate_During_Hurricane_Type_1 - Incoming_Rate_Not_Evacuated_Type_1) * dtINIT Population_Affected_Type_1 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Own*Household_Income_Census:_Less_Than_10K_and_Own) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_Before_Evacuation_Type_1)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_After_Evacuation_Type_1)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_During_Evacuation_Type_1)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_Not_Evacuation_Type_1)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Population_Affected_Type_2(t) = Population_Affected_Type_2(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_2 - Incoming_Rate_After_Hurricane_Type_2 - Incoming_Rate_During_Hurricane_Type_2 - Incoming_Rate_Not_Evacuated_Type_2) * dtINIT Population_Affected_Type_2 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Own*Household_Income_Census:_More_Than_10K_and_Own) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_Before_Evacuation_Type_2)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_After_Evacuation_Type_2)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_During_Evacuation_Type_2)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day

Incoming_Rate_Not_Evacuated_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_Not_Evacuation_Type_2)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Population_Affected_Type_3(t) = Population_Affected_Type_3(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_3 - Incoming_Rate_After_Hurricane_Type_3 - Incoming_Rate_During_Hurricane_Type_3 - Incoming_Rate_Not_Evacuated_Type_3) * dtINIT Population_Affected_Type_3 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Rent*Household_Income_Census:_Less_Than_10K_and_Rent) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_Before_Evacuation_Type_3)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_After_Evacuation_Type_3)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_During_Evacuation_Type_3)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_Not_Evacuation_Type_3)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Population_Affected_Type_4(t) = Population_Affected_Type_4(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_4 - Incoming_Rate_After_Hurricane_Type_4 - Incoming_Rate_Not_Evacuated_Type_4 - Incoming_Rate_During_Hurricane_Type_4) * dtINIT Population_Affected_Type_4 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Rent*Household_Income_Census:_More_Than_10K_Less_Than_40K_and_Rent*Race_Non_Hispanic_White_Income_More_Than_10K_Less_Than_40K_Renter) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_Before_Evacuation_Type_4)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day

Incoming_Rate_After_Hurricane_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_After_Evacuation_Type_4)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_Not_Evacuation_Type_4)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_During_Evacuation_Type_4)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Population_Affected_Type_5(t) = Population_Affected_Type_5(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_5 - Incoming_Rate_After_Hurricane_Type_5 - Incoming_Rate_During_Hurricane_Type_5 - Incoming_Rate_Not_Evacuated_Type_5) * dtINIT Population_Affected_Type_5 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Rent*Household_Income_Census:_More_Than_10K_Less_Than_40K_and_Rent*Race_Non_White_Income_More_Than_10K_Less_than_40K_Renter) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_Before_Evacuation_Type_5)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_After_Evacuation_Type_5)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_During_Evacuation_Type_5)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_Not_Evacuation_Type_5)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Population_Affected_Type_6(t) = Population_Affected_Type_6(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_6 - Incoming_Rate_After_Hurricane_Type_6 - Incoming_Rate_Not_Evacuated_Type_6 - Incoming_Rate_During_Hurricane_Type_6) * dtINIT Population_Affected_Type_6 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Rent*Household_Income_Census:_More_Than_30K_Less_Than_40K) {person}

UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_Before_Evacuation_Type_6)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_After_Evacuation_Type_6)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_Not_Evacuation_Type_6)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_During_Evacuation_Type_6)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Population_Affected_Type_7(t) = Population_Affected_Type_7(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_7 - Incoming_Rate_After_Hurricane_Type_7 - Incoming_Rate_During_Hurricane_Type_7 - Incoming_Rate_Not_Evacuated_Type_7) * dtINIT Population_Affected_Type_7 = INT(Total_Population_Affected*House_Ownership_Status_Census:_Live_with_Parents) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_Before_Evacuation_Type_7)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_After_Evacuation_Type_7)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_During_Evacuation_Type_7)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_Not_Evacuation_Type_7)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Population_Affected_Type_8(t) = Population_Affected_Type_8(t - dt) + (-Incoming_Rate_Before_Hurricane_Type_8 - Incoming_Rate_After_Hurricane_Type_8 -

Incoming_Rate_During_Hurricane_Type_8 -
Incoming_Rate_Not_Evacuated_Type_8) * dtINIT Population_Affected_Type_8 = INT(Total_Population_Affected*House_Ownership_Status:_Other) {person}
UNITS: person
OUTFLOWS:
Incoming_Rate_Before_Hurricane_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_Before_Evacuation_Type_8)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_After_Evacuation_Type_8)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_During_Evacuation_Type_8)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_Not_Evacuation_Type_8)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Total_Evacuated_Population_After_Hurricane(t) = Total_Evacuated_Population_After_Hurricane(t - dt) + (Incoming_Rate_After_Hurricane_Type_4 + Incoming_Rate_After_Hurricane_Type_5 + Incoming_Rate_After_Hurricane_Type_6 + Incoming_Rate_After_Hurricane_Type_7 + Incoming_Rate_After_Hurricane_Type_8 + Incoming_Rate_After_Hurricane_Type_1 + Incoming_Rate_After_Hurricane_Type_2 + Incoming_Rate_After_Hurricane_Type_3 - Total_Leaving_Rate_to_Shelter_After_Hurricane) * dtINIT Total_Evacuated_Population_After_Hurricane = 0 {person}
UNITS: person
INFLOWS:
Incoming_Rate_After_Hurricane_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_After_Evacuation_Type_4)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_After_Evacuation_Type_5)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_After_Evacuation_Type_6)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}

UNITS: person/day
Incoming_Rate_After_Hurricane_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_After_Evacuation_Type_7)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_After_Evacuation_Type_8)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_After_Evacuation_Type_1)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_After_Evacuation_Type_2)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
Incoming_Rate_After_Hurricane_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_After_Evacuation_Type_3)*(1/After_Input_Delay)*(STEP(1,2)-STEP(1,3))) {person/day}
UNITS: person/day
OUTFLOWS:
Total_Leaving_Rate_to_Shelter_After_Hurricane = INT(Total_Evacuated_Population_After_Hurricane*After_Fraction)/After_Evacuation_Delay_Duration {person/day}
UNITS: person/day
Total_Evacuated_Population_Before_Hurricane(t) = Total_Evacuated_Population_Before_Hurricane(t - dt) + (Incoming_Rate_Before_Hurricane_Type_1 + Incoming_Rate_Before_Hurricane_Type_2 + Incoming_Rate_Before_Hurricane_Type_3 + Incoming_Rate_Before_Hurricane_Type_4 + Incoming_Rate_Before_Hurricane_Type_5 + Incoming_Rate_Before_Hurricane_Type_6 + Incoming_Rate_Before_Hurricane_Type_7 + Incoming_Rate_Before_Hurricane_Type_8 - Total_Leaving_Rate_to_Shelter_Before_Hurricane) * dtINIT Total_Evacuated_Population_Before_Hurricane = 0 {person}
UNITS: person
INFLOWS:
Incoming_Rate_Before_Hurricane_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_Before_Evacuation_Type_1)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day

Incoming_Rate_Before_Hurricane_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_Before_Evacuation_Type_2)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_Before_Hurricane_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_Before_Evacuation_Type_3)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_Before_Hurricane_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_Before_Evacuation_Type_4)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_Before_Hurricane_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_Before_Evacuation_Type_5)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_Before_Hurricane_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_Before_Evacuation_Type_6)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_Before_Hurricane_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_Before_Evacuation_Type_7)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
Incoming_Rate_Before_Hurricane_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_Before_Evacuation_Type_8)*(1/Before_Input_Delay)*(STEP(1,1)-STEP(1,2))) {person/day}
UNITS: person/day
OUTFLOWS:
Total_Leaving_Rate_to_Shelter_Before_Hurricane = INT((Total_Evacuated_Population_Before_Hurricane*Before_Fraction)/Before_Evacuation_Delay_Duration) {person/day}
UNITS: person/day
Total_Evacuated_Population_During_Hurricane(t) = Total_Evacuated_Population_During_Hurricane(t - dt) + (Incoming_Rate_During_Hurricane_Type_5 + Incoming_Rate_During_Hurricane_Type_1 + Incoming_Rate_During_Hurricane_Type_2 + Incoming_Rate_During_Hurricane_Type_3 + Incoming_Rate_During_Hurricane_Type_4 + Incoming_Rate_During_Hurricane_Type_7 + Incoming_Rate_During_Hurricane_Type_8 + Incoming_Rate_During_Hurricane_Type_6 - Total_Leaving_Rate_to_Shelter_During_Hurricane) * dtINIT Total_Evacuated_Population_During_Hurricane = 0 {person}
UNITS: person

INFLOWS:
Incoming_Rate_During_Hurricane_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_During_Evacuation_Type_5)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_During_Evacuation_Type_1)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_During_Evacuation_Type_2)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_During_Evacuation_Type_3)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_During_Evacuation_Type_4)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_During_Evacuation_Type_7)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_During_Evacuation_Type_8)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
Incoming_Rate_During_Hurricane_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_During_Evacuation_Type_6)*(1/During_Input_Delay)*(STEP(1,3)-STEP(1,27))) {person/day}
UNITS: person/day
OUTFLOWS:
Total_Leaving_Rate_to_Shelter_During_Hurricane = INT(Total_Evacuated_Population_During_Hurricane*During_Fraction)/During_Evacuation_Delay_Duration {person/day}
UNITS: person/day
Total_Not_Evacuated_Population(t) = Total_Not_Evacuated_Population(t - dt) + (Incoming_Rate_Not_Evacuated_Type_1 + Incoming_Rate_Not_Evacuated_Type_2 + Incoming_Rate_Not_Evacuated_Type_3 + Incoming_Rate_Not_Evacuated_Type_4 + Incoming_Rate_Not_Evacuated_Type_5 + Incoming_Rate_Not_Evacuated_Type_6 + Incoming_Rate_Not_Evacuated_Type_7 +

Incoming_Rate_Not_Evacuated_Type_8 - Total_Leaving_Rate_to_Shelter_Not_Evacuated_Population) * dtINIT Total_Not_Evacuated_Population = 0 {person}
UNITS: person
INFLOWS:
Incoming_Rate_Not_Evacuated_Type_1 = INT((Population_Affected_Type_1*Client's_Disposition_Not_Evacuation_Type_1)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_2 = INT((Population_Affected_Type_2*Client's_Disposition_Not_Evacuation_Type_2)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_3 = INT((Population_Affected_Type_3*Client's_Disposition_Not_Evacuation_Type_3)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_4 = INT((Population_Affected_Type_4*Client's_Disposition_Not_Evacuation_Type_4)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_5 = INT((Population_Affected_Type_5*Client's_Disposition_Not_Evacuation_Type_5)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_6 = INT((Population_Affected_Type_6*Client's_Disposition_Not_Evacuation_Type_6)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_7 = INT((Population_Affected_Type_7*Client's_Disposition_Not_Evacuation_Type_7)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
Incoming_Rate_Not_Evacuated_Type_8 = INT((Population_Affected_Type_8*Client's_Disposition_Not_Evacuation_Type_8)*(1/Not_Input_Delay)) {person/day}
UNITS: person/day
OUTFLOWS:
Total_Leaving_Rate_to_Shelter_Not_Evacuated_Population = INT(Total_Not_Evacuated_Population*Not_Fraction)/Not_Evacuation_Delay_Duration {person/day}
UNITS: person/day
Total_Population_Affected(t) = Total_Population_Affected(t - dt)INIT Total_Population_Affected = 0 {person}
UNITS: person
After_Evacuation_Delay_Duration = 1 {day}

UNITS: day
After_Fraction = 0.4299 {unitless}
UNITS: Unitless
After_Input_Delay = 1 {day}
UNITS: day
Before_Evacuation_Delay_Duration = 4 {day}
UNITS: day
Before_Fraction = 0.2485 {unitless}
UNITS: Unitless
Before_Input_Delay = 1 {day}
UNITS: day
Client's_Disposition_After_Evacuation_Type_1 = 0.1571 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_2 = 0.1065 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_3 = 0.2132 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_4 = 0.1304 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_5 = 0.2510 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_6 = 0.1216 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_7 = 0.1176 {unitless}
UNITS: Unitless
Client's_Disposition_After_Evacuation_Type_8 = 0 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_1 = 0.5286 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_2 = 0.7049 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_3 = 0.5809 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_4 = 0.7174 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_5 = 0.6426 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_6 = 0.8108 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_7 = 0.7647 {unitless}
UNITS: Unitless
Client's_Disposition_Before_Evacuation_Type_8 = 0.80 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_1 = 0.0143 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_2 = 0.0216 {unitless}

UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_3 = 0.0735 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_4 = 0.0217 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_5 = 0.0076 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_6 = 0.027 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_7 = 0.0196 {unitless}
UNITS: Unitless
Client's_Disposition_During_Evacuation_Type_8 = 0 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_1 = 0.3 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_2 = 0.1671 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_3 = 0.1324 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_4 = 0.1304 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_5 = 0.0989 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_6 = 0.0405 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_7 = 0.0980 {unitless}
UNITS: Unitless
Client's_Disposition_Not_Evacuation_Type_8 = 0.2 {unitless}
UNITS: Unitless
During_Evacuation_Delay_Duration = 1 {day}
UNITS: day
During_Fraction = 0.3902 {unitless}
UNITS: Unitless
During_Input_Delay = 1 {day}
UNITS: day
Not_Evacuation_Delay_Duration = 14 {day}
UNITS: day
Not_Fraction = 0.0739 {unitless}
UNITS: Unitless
Not_Input_Delay = 1 {day}
UNITS: day
People_in_Shelter_Relative_Changing_Rate = (Shelter_Incoming_Rate-Shelter_Leaving_Rate)/People_in_Shelter {1/day}
UNITS: 1/day

Cash_Donations(t) = Cash_Donations(t - dt) + (Income - Expenses) * dtINIT Cash_Donations = 0 {USD}
UNITS: USD
INFLOWS:
Income = INT(Donors*Donation_per_Person/Cash_Donations_Input_Delay) {USD/day}
UNITS: USD/day
OUTFLOWS:
Expenses = INT((Dollars_Spent_on_Meals+Dollars_Spent_on_Others+Dollars_Spent_on_Financial_Assistance)/Cash_Donations_Output_Delay) {USD/day}
UNITS: USD/day
Donors(t) = Donors(t - dt) + (Donors_Rate - Donors_Death_Rate) * dtINIT Donors = 0
UNITS: person
INFLOWS:
Donors_Rate = INT(Weighted_People_for_Donation/Donors_Input_Delay) {person/day}
UNITS: person/day
OUTFLOWS:
Donors_Death_Rate = INT(Donors*Death_Rate) {person/day}
UNITS: person/day
Financial_Assistance_Available(t) = Financial_Assistance_Available(t - dt) + (Financial_Assistance_Input_Rate) * dtINIT Financial_Assistance_Available = Financial_Assistance_Fund {USD}
UNITS: USD
INFLOWS:
Financial_Assistance_Input_Rate = INT(Dollars_Spent_on_Financial_Assistance/Financial_Assistance_Input_Delay) {USD/day}
UNITS: USD/day
Financial_Assistance_Fund(t) = Financial_Assistance_Fund(t - dt)INIT Financial_Assistance_Fund = 0 {USD}
UNITS: USD
Meals_Available(t) = Meals_Available(t - dt) + (Meals_Purchased_Output_Rate) * dtINIT Meals_Available = Meals_Stored {unit}
UNITS: unit
INFLOWS:
Meals_Purchased_Output_Rate = INT(Meals_Purchased/Meals_Purchased_Output_Delay) {unit/day}
UNITS: unit/day
Meals_Purchased(t) = Meals_Purchased(t - dt) + (Meals_Purchased_Input_Rate - Meals_Purchased_Output_Rate) * dtINIT Meals_Purchased = 0 {unit}
UNITS: unit
INFLOWS:

Meals_Purchased_Input_Rate = INT((Dollars_Spent_on_Meals/Price_per_Meal)/Meals_Purchased_Input_Delay) {unit/day}
UNITS: unit/day
OUTFLOWS:
Meals_Purchased_Output_Rate = INT(Meals_Purchased/Meals_Purchased_Output_Delay) {unit/day}
UNITS: unit/day
Meals_Stored(t) = Meals_Stored(t - dt)INIT Meals_Stored = 0 {unit}
UNITS: unit
Not_Eligible_Population(t) = Not_Eligible_Population(t - dt) + (Not_Eligible_Growth_Rate - Not_Eligible_Death_Rate) * dtINIT Not_Eligible_Population = 0 {person}
UNITS: person
INFLOWS:
Not_Eligible_Growth_Rate = INT((Population_Over__18_Years_Old*Not_Eligible_Proportion)/Eligible_Population_Input_Delay) {person/day}
UNITS: person/day
OUTFLOWS:
Not_Eligible_Death_Rate = INT(Not_Eligible_Population*Death_Rate) {person/day}
UNITS: person/day
Potential_People_for_Donation(t) = Potential_People_for_Donation(t - dt) + (Donation_Growth_Rate - Donors_Rate - Potential_People_for_Donation_Death_Rate) * dtINIT Potential_People_for_Donation = 0 {person}
UNITS: person
INFLOWS:
Donation_Growth_Rate = INT((Population_Over__18_Years_Old*Donors_Proportion)/Donors_Population_Input_Delay) {person/day}
UNITS: person/day
OUTFLOWS:
Donors_Rate = INT(Weighted_People_for_Donation/Donors_Input_Delay) {person/day}
UNITS: person/day
Potential_People_for_Donation_Death_Rate = INT(Potential_People_for_Donation*Death_Rate) {person/day}
UNITS: person/day
Potential_People_for_Recruiting(t) = Potential_People_for_Recruiting(t - dt) + (Recruiting_Growth_Rate - Recruiting_Death_Rate) * dtINIT Potential_People_for_Recruiting = 0 {person}
UNITS: person
INFLOWS:

Recruiting_Growth_Rate = INT((Population_Over__18_Years_Old*Recruiting_Proportion)/Recruiting_Population_Input_Delay) {person/day}
UNITS: person/day
OUTFLOWS:
Recruiting_Death_Rate = INT(Potential_People_for_Recruiting*Death_Rate) {person/day}
UNITS: person/day
Bad_Perceptions = IF Financial_Assistance = 1 AND Mental_Health_Care=1 THEN 0.027 ELSE IF Financial_Assistance = 1 AND Mental_Health_Care=0 AND Meals=1 THEN 0.0532 ELSE IF Financial_Assistance = 1 AND Mental_Health_Care=0 AND Meals=0 THEN 0.0865 ELSE IF Financial_Assistance=0 AND Meals=1 THEN 0.1207 ELSE 0.4092 {unitless}
UNITS: Unitless
Cash_Donations_Input_Delay = 0 {day}
UNITS: day
Cash_Donations_Output_Delay = 0 {day}
UNITS: day
Client's_Satisfaction = Service_Quality {unitless}
UNITS: Unitless
Dollars_Spent_on_Financial_Assistance = INT(Cash_Donations*Financial_Assistance_%/100) {USD}
UNITS: USD
Dollars_Spent_on_Meals = INT(Cash_Donations*Meals_%/100) {USD}
UNITS: USD
Dollars_Spent_on_Others = INT(Cash_Donations*Others_%/100) {USD}
UNITS: USD
Donation_per_Person = 0 {USD/person}
UNITS: USD/person
Donors_Input_Delay = 0 {day}
UNITS: day
Donors_Population_Input_Delay = 0 {day}
UNITS: day
Donors_Proportion = 0 {unitless}
UNITS: Unitless
Eligible_Population_Input_Delay = 0 {day}
UNITS: day
Financial_Assistance = IF Delivered_Financial_Assistance>=Required_Financial_Assistance THEN 1 ELSE 0 {unitless}
UNITS: Unitless
Financial_Assistance_% = 0 {unitless}
UNITS: Unitless
Financial_Assistance_Input_Delay = 0 {day}
UNITS: day

Good_Perceptions = IF Financial_Assistance = 1 AND Mental_Health_Care=1 THEN 0.9081 ELSE IF Financial_Assistance = 1 AND Mental_Health_Care=0 AND Meals=1 THEN 0.8658 ELSE IF Financial_Assistance = 1 AND Mental_Health_Care=0 AND Meals=0 THEN 0.7798 ELSE IF Financial_Assistance=0 AND Meals=1 THEN 0.7586 ELSE 0.4545 {unitless}
UNITS: Unitless
Meals = IF Served_Meals >= Required_Meals THEN 1 ELSE 0 {unitless}
UNITS: Unitless
Meals_% = 0 {unitless}
UNITS: Unitless
Meals_Purchased_Input_Delay = 0 {day}
UNITS: day
Meals_Purchased_Output_Delay = 0 {day}
UNITS: day
Mental_Health_Care = IF DSHR_Capacity>=DSHR_Required THEN 1 ELSE 0 {unitless}
UNITS: Unitless
Not_Eligible_Proportion = 1-(Donors_Proportion+Recruiting_Proportion)
UNITS: Unitless
Others_% = 0 {unitless}
UNITS: Unitless
Price_per_Meal = 0 {USD/unit}
UNITS: USD/unit
Recruiting_Population_Input_Delay = 0 {day}
UNITS: day
Recruiting_Proportion = 0 {unitless}
UNITS: Unitless
Service_Quality = Good_Perceptions {unitless}
UNITS: Unitless
Weighted_People_for_Donation = INT(IF People_with_Good_Opinion>=People_with_Bad_Opinion THEN (INT(Potential_People_for_Donation* 0.90)) ELSE (INT(Potential_People_for_Donation* 0.10))) {person}
UNITS: person

People_with_Bad_Opinion(t) = People_with_Bad_Opinion(t - dt) + (Bad_Opinion_Spread_Rate - Bad_Opinion_Leaving_Rate) * dtINIT People_with_Bad_Opinion = Bad_Perceptions {unitless}
UNITS: Unitless
INFLOWS:
Bad_Opinion_Spread_Rate = Media_Bad_News_Spread_Rate*People_with_Neutral_Opinion {1/day}
UNITS: 1/day
OUTFLOWS:

Bad_Opinion_Leaving_Rate = (Shelter_Leaving_Rate/people_in_shelter+people_in_shelter_relative_changing_rate)*People_with_Bad_Opinion {1/day}
UNITS: 1/day
People_with_Good_Opinion(t) = People_with_Good_Opinion(t - dt) + (Good_Opinion_Spread_Rate - Good_Opinion_Leaving_Rate) * dtINIT People_with_Good_Opinion = Good_Perceptions {unitless}
UNITS: Unitless
INFLOWS:
Good_Opinion_Spread_Rate = Media_Good_News_Spread_Rate*People_with_Neutral_Opinion {1/day}
UNITS: 1/day
OUTFLOWS:
Good_Opinion_Leaving_Rate = (Shelter_Leaving_Rate/people_in_shelter+People_in_Shelter_Relative_Changing_Rate)*People_with_Good_Opinion {1/day}
UNITS: 1/day
People_with_Neutral_Opinion(t) = People_with_Neutral_Opinion(t - dt) + (Neutral_Opinion_Incoming_Rate - Good_Opinion_Spread_Rate - Bad_Opinion_Spread_Rate - Neutral_Opinion_Leaving_Rate) * dtINIT People_with_Neutral_Opinion = 1-(People_with_Good_Opinion+People_with_Bad_Opinion) {unitless}
UNITS: Unitless
INFLOWS:
Neutral_Opinion_Incoming_Rate = Shelter_Incoming_Rate/People_in_Shelter {1/day}
UNITS: 1/day
OUTFLOWS:
Good_Opinion_Spread_Rate = Media_Good_News_Spread_Rate*People_with_Neutral_Opinion {1/day}
UNITS: 1/day
Bad_Opinion_Spread_Rate = Media_Bad_News_Spread_Rate*People_with_Neutral_Opinion {1/day}
UNITS: 1/day
Neutral_Opinion_Leaving_Rate = (Shelter_Leaving_Rate/People_in_Shelter+People_in_Shelter_Relative_Changing_Rate)*People_with_Neutral_Opinion {1/day}
UNITS: 1/day
Population_Over__18_Years_Old(t) = Population_Over__18_Years_Old(t - dt) + (Population_Over_18_Years_Old_Growth_Rate - Population_Over_18_Years_Old_Death_Rate) * dtINIT Population_Over__18_Years_Old = 1 {person}
UNITS: person
INFLOWS:

Population_Over_18_Years_Old_Growth_Rate = INT(Total__Census_Population*Population_Proportion_Over_18_Years_Old) {person/day}
UNITS: person/day
OUTFLOWS:
Population_Over_18_Years_Old_Death_Rate = INT(Population_Over__18_Years_Old*Death_Rate) {person/day}
UNITS: person/day
Total__Census_Population(t) = Total__Census_Population(t - dt) + (Births - Deaths) * dtINIT Total__Census_Population = IF Hurricane_Threaten=1 THEN 295895897 ELSE 0 {person}
UNITS: person
INFLOWS:
Births = INT(Total__Census_Population*Birth_Rate) {person/day}
UNITS: person/day
OUTFLOWS:
Deaths = INT(Total__Census_Population*Death_Rate) {person/day}
UNITS: person/day
Bad_News_Spread_Rate = 0 {unitless}
UNITS: 1/day
Birth_Rate = 0 {1/day}
UNITS: 1/day
Death_Rate = 0 {1/day}
UNITS: 1/day
Good_News_Spread_Rate = 0 {unitless}
UNITS: 1/day
Household_Income_Census:_Less_Than_10K_and_Own = 0 {unitless}
UNITS: Unitless
Household_Income_Census:_Less_Than_10K_and_Rent = 0 {unitless}
UNITS: Unitless
Household_Income_Census:_More_Than_10K_and_Own = 1-(Household_Income_Census:_Less_Than_10K_and_Own) {unitless}
UNITS: Unitless
Household_Income_Census:_More_Than_10K_Less_Than_40K_and_Rent = 0 {unitless}
UNITS: Unitless
Household_Income_Census:_More_Than_30K_Less_Than_40K = 1-(Household_Income_Census:_Less_Than_10K_and_Rent+Household_Income_Census:_More_Than_10K_Less_Than_40K_and_Rent) {unitless}
UNITS: Unitless
House_Ownership_Status:_Other = (1-((House_Ownership_Status_Census:_Own)+(House_Ownership_Status_Census:_Rent)+(House_Ownership_Status_Census:_Live_with_Parents))) {unitless}
UNITS: Unitless
House_Ownership_Status_Census:_Live_with_Parents = 0 {unitless}
UNITS: Unitless

House_Ownership_Status_Census:_Own = 0 {unitless}
UNITS: Unitless
House_Ownership_Status_Census:_Rent = 0 {unitless}
UNITS: Unitless
Hurricane_Level = 0 {unitless}
UNITS: Unitless
Hurricane_Threaten = 0 {unitless}
UNITS: Unitless
Media_Bad_News_Spread_Rate = Bad_News_Spread_Rate*People_with_Bad_Opinion {1/day}
UNITS: 1/day
Media_Good_News_Spread_Rate = Good_News_Spread_Rate*People_with_Good_Opinion {1/day}
UNITS: 1/day
Population_Proportion_Over_18_Years_Old = 0 {1/day}
UNITS: 1/day
Race_Non_Hispanic_White_Income_More_Than_10K_Less_Than_40K_Renter = 0 {unitless}
UNITS: Unitless
Race_Non_White_Income_More_Than_10K_Less_than_40K_Renter = (1-((Race_Non_Hispanic_White_Income_More_Than_10K_Less_Than_40K_Renter)))/4 {unitless}
UNITS: Unitless
Total_People_with_Opinions = { Place right hand side of equation here... } + People_with_Good_Opinion + People_with_Bad_Opinion + People_with_Neutral_Opinion {unitless}
UNITS: Unitless

ARC_Staff(t) = ARC_Staff(t - dt)INIT ARC_Staff = 0 {person}
UNITS: person
Delivered_Financial_Assistance(t) = Delivered_Financial_Assistance(t - dt) + (Financial_Assistance_Incoming_Rate - Financial_Assistance_Deploying_Rate) * dtINIT Delivered_Financial_Assistance = 0 {USD}
UNITS: USD
INFLOWS:
Financial_Assistance_Incoming_Rate = INT((Financial_Assistance_to_be_Delivered-Delivered_Financial_Assistance)/Financial_Assistance_Required_Input_Delay) {USD/day}
UNITS: USD/day
OUTFLOWS:
Financial_Assistance_Deploying_Rate = INT((Delivered_Financial_Assistance-Financial_Assistance_to_be_Delivered)/Financial_Assistance_Deployed_Delay) {USD/day}
UNITS: USD/day

DSHR_Capacity(t) = DSHR_Capacity(t - dt) + (Volunteers_Trained_Leaving_Rate - DSHR_Deploying_Rate) * dtINIT DSHR_Capacity = 0 {person}
UNITS: person
INFLOWS:
Volunteers_Trained_Leaving_Rate = INT(DSHR_Required/Trained_Delay_Duration) {person/day}
UNITS: person/day
OUTFLOWS:
DSHR_Deploying_Rate = INT((DSHR_Capacity-(People_in_Shelter/Shelter_Limit)*DSHR_Limit)/DSHR_Deploying_Delay) {person/day}
UNITS: person/day
New_Volunteers(t) = New_Volunteers(t - dt) + (New_Vounteers_Recruiting_Rate - New_Volunteers_Incoming_Rate) * dtINIT New_Volunteers = 0 {person}
UNITS: person
INFLOWS:
New_Vounteers_Recruiting_Rate = ROUND(New_Volunteers_Recruited/New_Volunteers_Input_Delay) {person/day}
UNITS: person/day
OUTFLOWS:
New_Volunteers_Incoming_Rate = INT((New_Volunteers/Volunteer_Incoming_Delay)) {person/day}
UNITS: person/day
Opened_Cases(t) = Opened_Cases(t - dt) + (Cases_Opening_Rate - Cases_Closing_Rate) * dtINIT Opened_Cases = 0 {unit}
UNITS: unit
INFLOWS:
Cases_Opening_Rate = SMTH1(INT((Cases_to_be_Opened-Opened_Cases)/Cases_Opening_Delay), 0.85) {unit/day}
UNITS: unit/day
OUTFLOWS:
Cases_Closing_Rate = SMTH1(INT((Opened_Cases-Cases_to_be_Opened)/Cases_Closing_Delay),0.85) {unit/day}
UNITS: unit/day
Opened_Shelters(t) = Opened_Shelters(t - dt) + (Shelter_Opening_Rate - Shelter_Closing_Rate) * dtINIT Opened_Shelters = 0 {unit}
UNITS: unit
INFLOWS:
Shelter_Opening_Rate = INT((Required_Opened_Shelters-Opened_Shelters)/Shelter_Opening_Delay) {unit/day}
UNITS: unit/day
OUTFLOWS:
Shelter_Closing_Rate = INT((Opened_Shelters-(People_in_Shelter/Shelter_Limit))/Shelter_Closing_Delay) {unit/day}
UNITS: unit/day

Served_Meals(t) = Served_Meals(t - dt) + (Meals_Incoming_Rate - Meals_Deploying_Rate) * dtINIT Served_Meals = 0 {unit}
UNITS: unit
INFLOWS:
Meals_Incoming_Rate = INT((Meals_to_be_Served-Served_Meals)/Served_Meals_Input_Delay) {unit/day}
UNITS: unit/day
OUTFLOWS:
Meals_Deploying_Rate = INT((Served_Meals-Meals_to_be_Served)/Meals_Delivered_Delay) {unit/day}
UNITS: unit/day
Staff_Capacity(t) = Staff_Capacity(t - dt) + (- Staff_Incoming_Rate) * dtINIT Staff_Capacity = INT(ARC_Staff*Staff_Availability_Proportion) {person}
UNITS: person
OUTFLOWS:
Staff_Incoming_Rate = INT(Staff_Capacity/Staff_Deploying_Delay) {person/day}
UNITS: person/day
Volunteers_Trained(t) = Volunteers_Trained(t - dt) + (New_Volunteers_Incoming_Rate + Staff_Incoming_Rate - Volunteers_Trained_Leaving_Rate) * dtINIT Volunteers_Trained = 0 {person}
UNITS: person
INFLOWS:
New_Volunteers_Incoming_Rate = INT((New_Volunteers/Volunteer_Incoming_Delay)) {person/day}
UNITS: person/day
Staff_Incoming_Rate = INT(Staff_Capacity/Staff_Deploying_Delay) {person/day}
UNITS: person/day
OUTFLOWS:
Volunteers_Trained_Leaving_Rate = INT(DSHR_Required/Trained_Delay_Duration) {person/day}
UNITS: person/day
Cases_Closing_Delay = 0 {day}
UNITS: day
Cases_Opening_Delay = 0 {day}
UNITS: day
Cases_Processed = DSHR_Capacity*Cases_Processed_Limit {unit}
UNITS: unit
Cases_Processed_Limit = 0 {unit/person}
UNITS: unit/person
Cases_to_be_Opened = IF Required_Cases< Cases_Processed THEN Required_Cases ELSE Cases_Processed {unit}
UNITS: unit
DSHR_Deploying_Delay = 0 {day}
UNITS: day
DSHR_Limit = 0 {person/unit}
UNITS: person/unit

DSHR_Required = INT((People_Requiring_Shelter/Shelter_Limit)*DSHR_Limit) {person}
UNITS: person
Financial_Assistance_Delivered_Limit = INT(Financial_Assistance_Limit*Number_of_Family_Group's_People_per_Case*Cases_Processed_Limit) {USD/person}
UNITS: USD/person
Financial_Assistance_Deployed_Delay = 0 {day}
UNITS: day
Financial_Assistance_Limit = 0 {USD/person}
UNITS: USD/person
Financial_Assistance_Processed = INT(DSHR_Capacity*Financial_Assistance_Delivered_Limit) {USD}
UNITS: USD
Financial_Assistance_Ready = IF Required_Financial_Assistance<Financial_Assistance_Available THEN Required_Financial_Assistance ELSE Financial_Assistance_Available {USD}
UNITS: USD
Financial_Assistance_Required_Input_Delay = 0 {day}
UNITS: day
Financial_Assistance_to_be_Delivered = IF Financial_Assistance_Ready< Financial_Assistance_Processed THEN Financial_Assistance_Ready ELSE Financial_Assistance_Processed {USD}
UNITS: USD
Meals_Capacity = INT(DSHR_Capacity*Meals_Delivered_Limit) {unit}
UNITS: unit
Meals_Delivered_Delay = 0 {day}
UNITS: day
Meals_Delivered_Limit = 0 {unit/person}
UNITS: unit/person
Meals_Ready = IF Required_Meals < Meals_Available THEN Required_Meals ELSE Meals_Available {unit}
UNITS: unit
Meals_to_be_Served = IF Meals_Ready< Meals_Capacity THEN Meals_Ready ELSE Meals_Capacity {unit}
UNITS: unit
Meals__Limit = 0 {unit/person}
UNITS: unit/person
New_Volunteers_Input_Delay = 0 {day}
UNITS: day
New_Volunteers_Recruited = IF People_with_Good_Opinion>People_with_Bad_Opinion AND Hurricane_Level=1 THEN (Potential_People_for_Recruiting*0.50) ELSE IF People_with_Good_Opinion>People_with_Bad_Opinion AND Hurricane_Level=0 THEN (Potential_People_for_Recruiting*0.30) ELSE IF People_with_Bad_Opinion>People_with_Good_Opinion AND Hurricane_Level=1

THEN (Potential_People_for_Recruiting*0.15) ELSE (Potential_People_for_Recruiting*0.05) {person}
UNITS: person
Number_of_Family_Group's_People_per_Case = 0 {person/unit}
UNITS: person/unit
Required_Cases = INT(People_in_Shelter/Number_of_Family_Group's_People_per_Case) {unit}
UNITS: unit
Required_Financial_Assistance = INT(People_in_Shelter*Financial_Assistance_Limit) {USD}
UNITS: USD
Required_Meals = INT(People_in_Shelter*Meals__Limit) {unit}
UNITS: unit
Required_Opened_Shelters = INT(People_Requiring_Shelter/Shelter_Limit) {unit}
UNITS: unit
Served_Meals_Input_Delay = 0 {day}
UNITS: day
Shelter_Closing_Delay = 0 {day}
UNITS: day
Shelter_Limit = 0 {person/unit}
UNITS: person/unit
Shelter_Opening_Delay = 0 {day}
UNITS: day
Staff_Availability_Proportion = 0 {unitless}
UNITS: Unitless
Staff_Deploying_Delay = 0 {day}
UNITS: day
Trained_Delay_Duration = 0 {day}
UNITS: day
Volunteer_Incoming_Delay = 0 {day}
UNITS: day

Not in a sector
KATRINA_SMOOTH_DSHR_Capacity = SMTH1(KATRINA_DSHR_Capacity,1) {person}
UNITS: person
KATRINA_SMOOTH_Opened_Cases = SMTH1(KATRINA_Opened_Cases,1) {unit}
UNITS: unit
KATRINA_SMOOTH_Opened_Shelters = SMTH1(KATRINA_Opened_Shelters,1) {unit}
UNITS: unit
KATRINA_SMOOTH_People_in_Shelter = SMTH1(KATRINA_People_in_Shelter,1) {person}
UNITS: person

KATRINA_SMOOTH_Served_Meals = SMTH1(KATRINA_Served_Meals,1) {unit}
UNITS: unit
KATRINA_SMOOTH_Shelter_Incoming_Rate = SMTH1(KATRINA_Shelter_Incoming_Rate,1) {person/day}
UNITS: person/day
KATRINA_SMOOTH_Shelter_Leaving_Rate = SMTH1(KATRINA_Shelter_Leaving_Rate,1) {person/day}
UNITS: person/day
RITA_SMOOTH_DSHR_Capacity = SMTH1(RITA_DSHR_Capacity,1) {person}
UNITS: person
RITA_SMOOTH_Opened_Cases = SMTH1(RITA_Opened_Cases,1) {unit}
UNITS: unit
RITA_SMOOTH_Opened_Shelters = SMTH1(RITA_Opened_Shelters,1) {unit}
UNITS: unit
RITA_SMOOTH_People_in_Shelter = SMTH1(RITA_People_in_Shelter,1) {person}
UNITS: person
RITA_SMOOTH_Served_Meals = SMTH1(RITA_Served_Meals,1) {unit}
UNITS: unit
RITA_SMOOTH_Shelter_Incoming_Rate = SMTH1(RITA_Shelter_Incoming_Rate,1) {person/day}
UNITS: person/day
RITA_SMOOTH_Shelter_Leaving_Rate = SMTH1(RITA_Shelter_Leaving_Rate,1) {person/day}
UNITS: person/day
KATRINA_Client's_Sastisfaction = GRAPH(TIME)
(1.00, 0.99), (2.00, 0.99), (3.00, 0.99), (4.00, 0.99), (5.00, 0.935), (6.00, 0.805), (7.00, 0.64), (8.00, 0.565), (9.00, 0.5), (10.0, 0.5), (11.0, 0.5), (12.0, 0.5), (13.0, 0.5), (14.0, 0.5), (15.0, 0.5), (16.0, 0.5), (17.0, 0.5), (18.0, 0.5), (19.0, 0.5), (20.0, 0.5), (21.0, 0.5), (22.0, 0.5), (23.0, 0.5), (24.0, 0.5), (25.0, 0.5), (26.0, 0.5), (27.0, 0.5)
KATRINA_DSHR_Capacity = GRAPH(TIME)
(1.00, 0.00), (2.00, 638), (3.00, 0.00), (4.00, 1712), (5.00, 2217), (6.00, 2678), (7.00, 3381), (8.00, 3887), (9.00, 4485), (10.0, 5105), (11.0, 12876), (12.0, 6696), (13.0, 7119), (14.0, 7867), (15.0, 4534), (16.0, 7119), (17.0, 8689), (18.0, 11959), (19.0, 11398), (20.0, 12242), (21.0, 13808), (22.0, 14067), (23.0, 1948), (24.0, 1083), (25.0, 2352), (26.0, 2533), (27.0, 2749)
UNITS: person
KATRINA_Opened_Cases = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 0.00), (4.00, 0.00), (5.00, 0.00), (6.00, 0.00), (7.00, 0.00), (8.00, 0.00), (9.00, 0.00), (10.0, 0.00), (11.0, 441), (12.0, 692), (13.0, 692), (14.0, 658), (15.0, 1502), (16.0, 2648), (17.0, 2951), (18.0, 3622), (19.0, 5022), (20.0, 5134), (21.0, 11976), (22.0, 6072), (23.0, 11099), (24.0, 5479), (25.0, 11314), (26.0, 16200), (27.0, 22755)
UNITS: unit

KATRINA_Opened_Shelters = GRAPH(TIME)
(1.00, 0.00), (2.00, 216), (3.00, 232), (4.00, 219), (5.00, 219), (6.00, 237), (7.00, 276), (8.00, 276), (9.00, 294), (10.0, 330), (11.0, 351), (12.0, 331), (13.0, 352), (14.0, 342), (15.0, 290), (16.0, 250), (17.0, 200), (18.0, 150), (19.0, 100), (20.0, 50.0), (21.0, 25.0), (22.0, 10.0), (23.0, 4.00), (24.0, 149), (25.0, 138), (26.0, 136), (27.0, 142)
UNITS: unit
KATRINA_People_in_Shelter = GRAPH(TIME)
(1.00, 1315), (2.00, 34324), (3.00, 39197), (4.00, 60098), (5.00, 51482), (6.00, 64440), (7.00, 65155), (8.00, 47371), (9.00, 62878), (10.0, 67521), (11.0, 70227), (12.0, 69270), (13.0, 64416), (14.0, 63696), (15.0, 53772), (16.0, 45267), (17.0, 34433), (18.0, 34141), (19.0, 30662), (20.0, 26592), (21.0, 25622), (22.0, 26029), (23.0, 23045), (24.0, 19665), (25.0, 19520), (26.0, 19287), (27.0, 19356)
UNITS: person
KATRINA_Served_Meals = GRAPH(TIME)
(1.00, 228000), (2.00, 613499), (3.00, 636762), (4.00, 92880), (5.00, 133164), (6.00, 177200), (7.00, 40488), (8.00, 895303), (9.00, 585840), (10.0, 398960), (11.0, 391428), (12.0, 425954), (13.0, 366127), (14.0, 373220), (15.0, 373885), (16.0, 337138), (17.0, 307831), (18.0, 337578), (19.0, 390547), (20.0, 246482), (21.0, 239495), (22.0, 451195), (23.0, 211834), (24.0, 221822), (25.0, 239216), (26.0, 246483), (27.0, 322057)
UNITS: unit
KATRINA_Shelter_Incoming_Rate = GRAPH(TIME)
(1.00, 1315), (2.00, 33009), (3.00, 4873), (4.00, 60098), (5.00, 0.00), (6.00, 12958), (7.00, 715), (8.00, 0.00), (9.00, 15507), (10.0, 4643), (11.0, 2706), (12.0, 0.00), (13.0, 0.00), (14.0, 0.00), (15.0, 0.00), (16.0, 0.00), (17.0, 0.00), (18.0, 0.00), (19.0, 0.00), (20.0, 0.00), (21.0, 0.00), (22.0, 407), (23.0, 0.00), (24.0, 0.00), (25.0, 0.00), (26.0, 0.00), (27.0, 69.0)
UNITS: person/day
KATRINA_Shelter_Leaving_Rate = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 0.00), (4.00, 0.00), (5.00, 8616), (6.00, 0.00), (7.00, 0.00), (8.00, 17784), (9.00, 0.00), (10.0, 0.00), (11.0, 0.00), (12.0, 957), (13.0, 4854), (14.0, 720), (15.0, 9924), (16.0, 8505), (17.0, 10834), (18.0, 292), (19.0, 3479), (20.0, 4070), (21.0, 970), (22.0, 0.00), (23.0, 2984), (24.0, 3380), (25.0, 145), (26.0, 233), (27.0, 0.00)
UNITS: person/day
RITA_Client's_Sastisfaction = GRAPH(TIME)
(1.00, 0.905), (2.00, 0.87), (3.00, 0.755), (4.00, 0.565), (5.00, 0.5), (6.00, 0.46), (7.00, 0.415), (8.00, 0.295), (9.00, 0.3), (10.0, 0.265), (11.0, 0.155), (12.0, 0.135), (13.0, 0.09), (14.0, 0.08), (15.0, 0.1), (16.0, 0.045), (17.0, 0.045)
RITA_DSHR_Capacity = GRAPH(TIME)
(1.00, 3221), (2.00, 3239), (3.00, 3285), (4.00, 1392), (5.00, 1501), (6.00, 0.00), (7.00, 0.00), (8.00, 1531), (9.00, 1542), (10.0, 1545), (11.0, 1592), (12.0, 1635), (13.0, 1661), (14.0, 1706), (15.0, 0.00), (16.0, 0.00), (17.0, 3351)
UNITS: person
RITA_Opened_Cases = GRAPH(TIME)

(1.00, 0.00), (2.00, 0.00), (3.00, 2900), (4.00, 17483), (5.00, 2967), (6.00, 16683), (7.00, 16424), (8.00, 28114), (9.00, 14238), (10.0, 9650), (11.0, 29994), (12.0, 25204), (13.0, 16435), (14.0, 17914), (15.0, 16683), (16.0, 5771), (17.0, 480)
UNITS: unit
RITA_Opened_Shelters = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 213), (4.00, 289), (5.00, 226), (6.00, 301), (7.00, 288), (8.00, 287), (9.00, 280), (10.0, 299), (11.0, 261), (12.0, 257), (13.0, 245), (14.0, 202), (15.0, 186), (16.0, 183), (17.0, 7.00)
UNITS: unit
RITA_People_in_Shelter = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 34816), (4.00, 54403), (5.00, 31551), (6.00, 77482), (7.00, 44382), (8.00, 41215), (9.00, 36373), (10.0, 31449), (11.0, 31809), (12.0, 28270), (13.0, 24480), (14.0, 22177), (15.0, 21766), (16.0, 20975), (17.0, 229)
UNITS: person
RITA_Served_Meals = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 121520), (4.00, 339084), (5.00, 250624), (6.00, 298006), (7.00, 347223), (8.00, 413935), (9.00, 461599), (10.0, 294550), (11.0, 385655), (12.0, 459604), (13.0, 371818), (14.0, 409199), (15.0, 425825), (16.0, 318264), (17.0, 59823)
UNITS: unit
RITA_Shelter_Incoming_Rate = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 34816), (4.00, 19587), (5.00, 0.00), (6.00, 45931), (7.00, 0.00), (8.00, 0.00), (9.00, 0.00), (10.0, 0.00), (11.0, 0.00), (12.0, 0.00), (13.0, 0.00), (14.0, 0.00), (15.0, 0.00), (16.0, 0.00), (17.0, 0.00)
UNITS: person/day
RITA_Shelter_Leaving_Rate = GRAPH(TIME)
(1.00, 0.00), (2.00, 0.00), (3.00, 0.00), (4.00, 0.00), (5.00, 22852), (6.00, 0.00), (7.00, 33100), (8.00, 3167), (9.00, 4842), (10.0, 4924), (11.0, 360), (12.0, 3539), (13.0, 3790), (14.0, 2303), (15.0, 411), (16.0, 791), (17.0, 20746)
UNITS: person/day

Equations Explanation

1. For the establishments of perceptions the likelihood obtained by SPSS AnswerTree^{TM} analysis (see Figure D-3) were grouped in the following categories:

   - Good Perceptions embraces: excellent, very good and good categories.
   - Bad Perceptions embraces: poor, DK and REF categories.
   - Neutral Perceptions embraces: fair category.

2. Step Function defined as: STEP (<height>,<time>) generates a one-time step change of specified *height*, which occurs at a specified *time*. For model

purposes this function was applied to control the period of timing of the evacuation.

Before: (STEP(1,1)-STEP(1,4))
After: (STEP(1,24)-STEP(1,27))
During: (STEP(1,4)-STEP(1,24))

Appendix G – Model Simulation Results

Table G-1. "Shelter Incoming Rate" Results: Reference Mode vs. Simulation. Author's Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
0	1315	0
1	1315	0
2	1315	600
3	33009	24900
4	4873	4800
5	60098	22200
6	0	2400
7	12958	20700
8	715	15300
9	0	26400
10	15507	12900
11	4643	15000
12	2706	6000
13	0	11400
14	0	29100
15	0	25500
16	0	12600
17	0	11700
18	0	6000
19	0	7500
20	0	24000
21	0	15600
22	0	9000
23	407	7200
24	0	4500
25	0	6900
26	0	16200
27	0	10800

Table G-2. “Shelter Leaving Rate” Results: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	358
6	8616	15120
7	0	22330
8	0	21236
9	17784	10618
10	0	5309
11	0	2655
12	0	26477
13	957	41292
14	4854	25862
15	720	12931
16	9924	6465
17	8505	3233
18	10834	21984
19	292	30430
20	3479	15836
21	4070	7918
22	970	3959
23	0	4276
24	2984	16177
25	3380	20317
26	145	10158
27	233	5079

Table G-3. “Opened Shelters” Results: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Opened Shelters	Simulation: Opened Shelters
0	0	0
1	0	0
2	0	0
3	216	2
4	232	85
5	219	101
6	219	175
7	237	182
8	276	201
9	276	178
10	294	195
11	330	202
12	351	235
13	331	246
14	352	196
15	342	155
16	290	154
17	250	153
18	200	170
19	150	179
20	100	131
21	50	110
22	25	109
23	10	112
24	4	123
25	149	124
26	138	93
27	136	79

Table G-4. “Served Meals” Results: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Served Meals	Simulation: Served Meals
0	228000	0
1	228000	0
2	228000	0
3	613499	0
4	636762	3760
5	92880	167132
6	133164	333410
7	177200	573677
8	40488	433754
9	895303	415823
10	585840	350526
11	398960	524128
12	391428	607629
13	425954	743429
14	366127	518185
15	373220	189374
16	373885	224993
17	337138	363252
18	307831	430732
19	337578	523872
20	390547	348049
21	246482	95814
22	239495	185616
23	451195	270117
24	211834	325567
25	221822	357731
26	239216	229284
27	246483	81702

Table G-5. “Opened Cases” Results: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Opened Cases	Simulation: Opened Cases
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	179
6	0	7650
7	0	15035
8	0	20070
9	0	13092
10	0	1829
11	0	0
12	441	12575
13	692	26602
14	692	29210
15	658	11308
16	1502	0
17	2648	0
18	2951	10184
19	3622	19903
20	5022	20214
21	5134	6050
22	11976	0
23	6072	1148
24	11099	8168
25	5479	14282
26	11314	13159
27	16200	2686

Table G-6. “DSHR Capacity” Results: Reference Mode vs. Simulation. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Deployed DSHR	Simulation: DSHR Capacity
0	0	0
1	0	0
2	0	0
3	638	20
4	0	889
5	1712	1928
6	2217	3720
7	2678	5594
8	3381	8157
9	3887	8999
10	4485	8133
11	5105	10536
12	12876	11965
13	6696	14093
14	7119	10914
15	7867	5919
16	4534	5926
17	7119	7614
18	8689	8623
19	11959	10036
20	11398	7464
21	12242	3641
22	13808	4525
23	14067	5595
24	1948	6424
25	1083	6939
26	2352	5051
27	2533	2771

Table G-7. “Client's Satisfaction” Results: Simulation. Author’s Elaboration, 2008.

Days	**Simulation: Client's Satisfaction**
0	0.4545
1	0.4545
2	0.4545
3	0.4545
4	0.4545
5	0.4545
6	0.4545
7	0.7586
8	0.7586
9	0.7586
10	0.4545
11	0.4545
12	0.4545
13	0.7586
14	0.7586
15	0.4545
16	0.4545
17	0.4545
18	0.4545
19	0.8658
20	0.8658
21	0.4545
22	0.4545
23	0.4545
24	0.4545
25	0.8658
26	0.8658
27	0.4545

Appendix H – Integration Error Tests Results

Time Step: 0.1 Days

Table H-1. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
0	1315	0
0.1	1315	0
0.2	1315	0
0.3	1315	0
0.4	1315	0
0.5	1315	0
0.6	1315	0
0.7	1315	0
0.8	1315	0
0.9	1315	0
1	1315	0
1.1	1315	300
1.2	1631.94	0
1.3	2234.126	600
1.4	3093.0334	1500
1.5	4182.99006	2100
1.6	5480.891054	2700
1.7	6965.941949	3600
1.8	8619.427754	4200
1.9	10424.50498	5100
2	12366.01448	5700
2.1	1.44E+04	6300
2.2	16006.82173	6900
2.3	17144.31956	7500
2.4	17886.7076	8100
2.5	18273.49684	8400
2.6	18340.24716	9300
2.7	18118.96244	9600
2.8	17638.4462	10200
2.9	16924.62158	11100
3	16000.81942	11400
3.1	14888.03748	11700
3.2	14438.78373	12300
3.3	14586.70536	12300
3.4	15272.08482	12600
3.5	16441.17634	12300
3.6	18045.60871	12600

Table H-2. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
3.7	20041.84783	12900
3.8	22390.71305	12900
3.9	25056.94175	12600
4	28008.79757	12600
4.1	3.12E+04	12600
4.2	33504.76603	12600
4.3	34962.12943	12900
4.4	35672.77649	12600
4.5	35711.37884	12600
4.6	35145.14095	12600
4.7	34034.54686	12300
4.8	32434.03217	12600
4.9	30392.58896	12600
5	27954.31006	12600
5.1	25158.87905	12600
5.2	22772.57115	12600
5.3	20754.47403	12600
5.4	19067.76663	12600
5.5	17679.30997	12900
5.6	16559.27897	12600
5.7	15680.83107	12600
5.8	15019.80797	12900
5.9	14554.46717	12600
6	14265.24045	12900
6.1	14134.51641	12900
6.2	13894.43477	12600
6.3	13555.93129	12900
6.4	13128.84816	12900
6.5	12622.04334	12900
6.6	12043.48901	12900
6.7	11400.36011	12900
6.8	10699.1141	12900
6.9	9945.562689	12900
7	9144.93642	12900
7.1	8301.942778	12600
7.2	7536.0985	12600
7.3	6839.68865	12600
7.4	6205.769785	12900
7.5	5628.092806	12600
7.6	5101.033526	12600
7.7	4619.530173	12600
7.8	4179.027156	12300
7.9	3775.42444	12300
8	3405.031996	12300
8.1	3064.528797	12300
8.2	2913.145917	12000

Table H-3. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.1 days. Author's Elaboration, 2008 (Continued).

Days	**KATRINA SMOOTH Shelter Incoming Rate**	**Simulation: Shelter Incoming Rate**
8.3	2931.971325	12000
8.4	3103.984193	12000
8.5	3413.865773	12000
8.6	3847.829196	11700
8.7	4393.466277	11400
8.8	5039.609649	11700
8.9	5776.208684	11400
9	6594.217816	11400
9.1	7485.496034	11400
9.2	8179.006431	11100
9.3	8694.525788	11100
9.4	9049.853209	11100
9.5	9261.007888	10800
9.6	9342.407099	10800
9.7	9307.026389	10800
9.8	9166.54375	10500
9.9	8931.469375	10800
10	8611.262438	10500
10.1	8214.436194	10200
10.2	7837.922575	10500
10.3	7479.690317	10200
10.4	7137.911285	10200
10.5	6810.940157	9900
10.6	6497.296141	10200
10.7	6195.646527	9900
10.8	5904.791874	9900
10.9	5623.652687	9900
11	5351.257418	9900
11.1	5086.731676	9900
11.2	4821.598509	9600
11.3	4555.918658	9600
11.4	4289.746792	9600
11.5	4023.132113	9300
11.6	3756.118902	9600
11.7	3488.747011	9600
11.8	3221.05231	9600
11.9	2953.067079	9300
12	2684.820371	9300
12.1	2416.338334	9300
12.2	2174.704501	9000
12.3	1957.234051	9000
12.4	1761.510646	9000
12.5	1585.359581	9000
12.6	1426.823623	9000
12.7	1284.141261	8700
12.8	1155.727135	8700

Table H-4. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.1 days. Author's Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
12.9	1040.154421	8700
13	936.138979	8700
13.1	842.5250811	8700
13.2	758.272573	8700
13.3	682.4453157	8400
13.4	614.2007841	8400
13.5	552.7807057	8400
13.6	497.5026352	8400
13.7	447.7523716	8400
13.8	402.9771345	8400
13.9	362.679421	8100
14	326.4114789	8100
14.1	293.770331	8100
14.2	264.3932979	7800
14.3	237.9539681	7800
14.4	214.1585713	7800
14.5	192.7427142	7800
14.6	173.4684428	7800
14.7	156.1215985	7800
14.8	140.5094386	7800
14.9	126.4584948	7800
15	113.8126453	7500
15.1	102.4313808	7500
15.2	92.18824269	7500
15.3	82.96941843	7500
15.4	74.67247658	7500
15.5	67.20522892	7500
15.6	60.48470603	7200
15.7	54.43623543	7200
15.8	48.99261189	7200
15.9	44.0933507	7200
16	39.68401563	7200
16.1	35.71561406	7200
16.2	32.14405266	6900
16.3	28.92964739	6900
16.4	26.03668265	6900
16.5	23.43301439	6900
16.6	21.08971295	6900
16.7	18.98074165	6600
16.8	17.08266749	6600
16.9	15.37440074	6600
17	13.83696067	6600
17.1	12.4532646	6600
17.2	11.20793814	6300
17.3	10.08714433	6600
17.4	9.078429893	6600

Table H-5. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.1 days. Author's Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
17.5	8.170586904	6600
17.6	7.353528213	6300
17.7	6.618175392	6300
17.8	5.956357853	6300
17.9	5.360722067	6300
18	4.824649861	6300
18.1	4.342184875	6300
18.2	3.907966387	6300
18.3	3.517169748	6300
18.4	3.165452774	6000
18.5	2.848907496	6000
18.6	2.564016747	6000
18.7	2.307615072	6000
18.8	2.076853565	6000
18.9	1.869168208	6000
19	1.682251387	6000
19.1	1.514026249	5700
19.2	1.362623624	6000
19.3	1.226361261	6000
19.4	1.103725135	5700
19.5	0.993352622	5700
19.6	0.89401736	5700
19.7	0.804615624	5700
19.8	0.724154061	5700
19.9	0.651738655	5700
20	0.58656479	5400
20.1	0.527908311	5400
20.2	0.47511748	5700
20.3	0.427605732	5700
20.4	0.384845158	5400
20.5	0.346360643	5400
20.6	0.311724578	5100
20.7	0.280552121	5400
20.8	0.252496908	5400
20.9	0.227247218	5100
21	0.204522496	5100
21.1	0.184070246	5400
21.2	4.235663222	5100
21.3	11.9520969	5100
21.4	22.96688721	5100
21.5	36.95019849	5100
21.6	53.60517864	5100
21.7	72.66466078	5100
21.8	93.8881947	5100
21.9	117.0593752	5100
22	141.9834377	4800

Table H-6. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
22.1	168.4850939	5100
22.2	188.2665845	5100
22.3	201.9999261	4800
22.4	210.2899335	4800
22.5	213.6809401	4800
22.6	212.6628461	4800
22.7	207.6765615	4800
22.8	199.1189054	4800
22.9	187.3470148	4800
23	172.6823133	4500
23.1	155.414082	4800
23.2	139.8726738	4800
23.3	125.8854064	4500
23.4	113.2968658	4800
23.5	101.9671792	4500
23.6	91.77046128	4500
23.7	82.59341515	4500
23.8	74.33407364	4500
23.9	66.90066628	4500
24	60.21059965	4500
24.1	54.18953968	4500
24.2	48.77058571	4200
24.3	43.89352714	4500
24.4	39.50417443	4200
24.5	35.55375699	4500
24.6	31.99838129	4200
24.7	28.79854316	4200
24.8	25.91868884	4500
24.9	23.32681996	4200
25	20.99413796	4200
25.1	18.89472417	4200
25.2	1.70E+01	4200
25.3	1.53E+01	4200
25.4	1.38E+01	4200
25.5	1.24E+01	3900
25.6	1.12E+01	4200
25.7	1.00E+01	3900
25.8	9.04E+00	4200
25.9	8.13E+00	4200
26	7.32E+00	4200
26.1	6.59E+00	3900
26.2	6.62E+00	3900
26.3	7.34E+00	4200
26.4	8.67E+00	3900
26.5	1.06E+01	4200
26.6	1.30E+01	3900

Table H-7. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.1 days. Author's Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
26.7	1.58E+01	3600
26.8	1.91E+01	3900
26.9	2.27E+01	3900
27	2.66E+01	3900

Table H-8. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
0	0	0
0.1	0	0
0.2	0	0
0.3	0	0
0.4	0	0
0.5	0	0
0.6	0	0
0.7	0	0
0.8	0	0
0.9	0	0
1	0	0
1.1	0	0
1.2	0	0
1.3	0	0
1.4	0	1
1.5	0	1
1.6	0	2
1.7	0	4
1.8	0	9
1.9	0	16
2	0	29
2.1	0.00E+00	48
2.2	0	76
2.3	0	113
2.4	0	161
2.5	0	222
2.6	0	297
2.7	0	387
2.8	0	493
2.9	0	615
3	0	755
3.1	0	913
3.2	0	1089
3.3	0	1283
3.4	0	1494
3.5	0	1723
3.6	0	1969
3.7	0	2229
3.8	0	2503
3.9	0	2789
4	0	3085
4.1	1.53E-12	3388
4.2	86.16	3698

Table H-9. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
4.3	249.864	4010
4.4	483.3576	4322
4.5	779.66184	4633
4.6	1132.495656	4939
4.7	1536.20609	5238
4.8	1985.705481	5528
4.9	2476.414933	5807
5	3004.21344	6073
5.1	3565.392096	6323
5.2	3984.292886	6557
5.3	4275.143598	6773
5.4	4450.749238	6969
5.5	4522.634314	7145
5.6	4501.170883	7301
5.7	4395.693794	7435
5.8	4214.604415	7548
5.9	3965.463974	7640
6	3655.077576	7711
6.1	3289.569819	7762
6.2	2960.612837	7793
6.3	2664.551553	7805
6.4	2398.096398	7799
6.5	2158.286758	7777
6.6	1942.458082	7739
6.7	1748.212274	7687
6.8	1573.391047	7622
6.9	1416.051942	7546
7	1274.446748	7461
7.1	1147.002073	7368
7.2	1210.141866	7269
7.3	1444.807679	7164
7.4	1833.846911	7056
7.5	2361.82222	6946
7.6	3014.839998	6835
7.7	3780.395998	6724
7.8	4647.236398	6614
7.9	5605.232759	6508
8	6645.269483	6404
8.1	7759.142534	6306
8.2	8583.788281	6212
8.3	9148.129453	6124
8.4	9478.196508	6041
8.5	9597.416857	5966
8.6	9526.875171	5897
8.7	9285.547654	5835
8.8	8890.512889	5779
8.9	8357.1416	5731

Table H-10. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
9	7699.26744	5689
9.1	6929.340696	5653
9.2	6236.406626	5624
9.3	5612.765964	5600
9.4	5051.489367	5581
9.5	4546.340431	5567
9.6	4091.706387	5557
9.7	3682.535749	5551
9.8	3314.282174	5548
9.9	2982.853956	5547
10	2684.568561	5548
10.1	2416.111705	5551
10.2	2174.500534	5554
10.3	1957.050481	5558
10.4	1761.345433	5561
10.5	1585.210889	5564
10.6	1426.689801	5566
10.7	1284.02082	5566
10.8	1155.618738	5563
10.9	1040.056865	5559
11	936.0511781	5552
11.1	842.4460603	5543
11.2	767.7714543	5530
11.3	710.1343089	5514
11.4	667.830878	5496
11.5	639.3277902	5474
11.6	623.2450112	5450
11.7	618.34051	5422
11.8	623.496459	5392
11.9	637.7068131	5358
12	660.0661318	5322
12.1	689.7595186	5284
12.2	755.4535668	5244
12.3	853.5482101	5203
12.4	980.8033891	5159
12.5	1134.30305	5114
12.6	1311.422745	5068
12.7	1509.800471	5021
12.8	1727.310424	4973
12.9	1962.039381	4925
13	2212.265443	4876
13.1	2476.438899	4828
13.2	2672.855009	4779
13.3	2808.289508	4730
13.4	2888.840557	4682
13.5	2919.996502	4635
13.6	2906.696851	4589

Table H-11. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
13.7	2853.387166	4544
13.8	2764.06845	4499
13.9	2642.341605	4457
14	2491.447444	4415
14.1	2314.3027	4375
14.2	2246.91243	4337
14.3	2278.301187	4301
14.4	2398.591068	4265
14.5	2598.891961	4232
14.6	2871.202765	4200
14.7	3208.322489	4169
14.8	3603.77024	4139
14.9	4051.713216	4111
15	4546.901894	4084
15.1	5084.611705	4058
15.2	5554.360534	4034
15.3	5962.944481	4010
15.4	6316.480033	3988
15.5	6620.47203	3966
15.6	6879.874827	3946
15.7	7099.147344	3926
15.8	7282.30261	3907
15.9	7432.952349	3888
16	7554.347114	3870
16.1	7649.412402	3852
16.2	7758.261162	3835
16.3	7879.515046	3818
16.4	8011.933541	3801
16.5	8154.400187	3783
16.6	8305.910168	3766
16.7	8465.559152	3749
16.8	8632.533236	3731
16.9	8806.099913	3713
17	8985.599922	3695
17.1	9170.439929	3676
17.2	9231.375936	3656
17.3	9180.798343	3636
17.4	9029.858509	3615
17.5	8788.592658	3594
17.6	8466.033392	3571
17.7	8070.310053	3548
17.8	7608.739047	3525
17.9	7087.905143	3501
18	6513.734628	3477
18.1	5891.561166	3452
18.2	5363.475049	3428
18.3	4920.067544	3403

Table H-12. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
18.4	4552.87079	3377
18.5	4254.263711	3352
18.6	4017.38734	3328
18.7	3836.068606	3303
18.8	3704.751745	3278
18.9	3618.436571	3254
19	3572.622914	3230
19.1	3563.260622	3206
19.2	3560.74456	3182
19.3	3564.390104	3159
19.4	3573.581094	3137
19.5	3587.762984	3114
19.6	3606.436686	3093
19.7	3629.153017	3072
19.8	3655.507716	3051
19.9	3685.136944	3031
20	3717.71325	3012
20.1	3752.941925	2993
20.2	3753.647732	2975
20.3	3723.282959	2957
20.4	3664.954663	2940
20.5	3581.459197	2923
20.6	3475.313277	2907
20.7	3348.781949	2891
20.8	3203.903754	2876
20.9	3042.513379	2861
21	2866.262041	2846
21.1	2676.635837	2831
21.2	2496.272253	2817
21.3	2324.245028	2802
21.4	2159.720525	2788
21.5	2001.948473	2773
21.6	1850.253625	2759
21.7	1704.028263	2744
21.8	1562.725437	2730
21.9	1425.852893	2715
22	1292.967604	2701
22.1	1163.670843	2686
22.2	1077.143759	2672
22.3	1029.109383	2657
22.4	1015.718445	2643
22.5	1033.5066	2629
22.6	1079.35594	2615
22.7	1150.460346	2601
22.8	1244.294312	2586
22.9	1358.58488	2573
23	1491.286392	2559

Table H-13. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.1 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
23.1	1640.557753	2545
23.2	1778.861978	2531
23.3	1907.29578	2517
23.4	2026.846202	2503
23.5	2138.401582	2489
23.6	2242.761424	2476
23.7	2340.645281	2462
23.8	2432.700753	2448
23.9	2519.510678	2435
24	2601.59961	2422
24.1	2679.439649	2408
24.2	2717.145684	2395
24.3	2718.731116	2382
24.4	2687.808004	2368
24.5	2627.627204	2355
24.6	2541.114483	2342
24.7	2430.903035	2329
24.8	2299.362732	2316
24.9	2148.626458	2303
25	1980.613813	2290
25.1	1797.052431	2277
25.2	1.63E+03	2264
25.3	1.49E+03	2251
25.4	1.35E+03	2238
25.5	1.24E+03	2226
25.6	1.13E+03	2213
25.7	1.04E+03	2201
25.8	9.55E+02	2188
25.9	8.81E+02	2176
26	8.16E+02	2164
26.1	7.57E+02	2152
26.2	7.03E+02	2140
26.3	6.51E+02	2129
26.4	6.02E+02	2118
26.5	5.56E+02	2107
26.6	5.12E+02	2096
26.7	4.70E+02	2086
26.8	4.30E+02	2076
26.9	3.92E+02	2066
27	3.55E+02	2056

Time Step: 0.125 Days

Table H-14. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.125 days. Author's Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
0	1315	0
0.125	1315	0
0.25	1315	0
0.375	1315	0
0.5	1315	0
0.625	1315	0
0.75	1315	0
0.875	1315	0
1	1315	0
1.125	1315	300
1.25	1810.21875	300
1.375	2738.753906	1200
1.5	4046.440918	2100
1.625	5685.885803	3000
1.75	7615.618828	3900
1.875	9799.353974	4500
2	12205.34098	5400
2.125	14805.79836	6600
2.25	16641.57356	7200
2.375	17808.25187	8100
2.5	18389.47038	8700
2.625	1.85E+04	9300
2.75	18079.11014	10200
2.875	17307.59637	10800
3	16192.89682	11400
3.125	14777.90972	12000
3.25	14402.68663	12300
3.375	14937.25705	12600
3.5	16267.8968	12600
3.625	18295.0972	12600
3.75	20931.78817	12900
3.875	24101.7834	12900
4	27738.41985	12600
4.125	31783.36737	12600
4.25	34383.6652	12600
4.375	35719.89455	12600
4.5	35950.06398	12600
4.625	35212.43098	12600
4.75	33627.97086	12600
4.875	31302.537	12900

Table H-15. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
5	28328.75113	12600
5.125	2.48E+04	12600
5.25	21891.66883	12600
5.375	19560.14773	12900
5.5	17722.53551	12600
5.625	16317.09357	12900
5.75	15289.80063	12900
5.875	14593.38805	12900
6	14186.49579	12900
6.125	14032.93382	12900
6.25	13707.27022	12900
6.375	13231.01769	12600
6.5	12622.99985	12900
6.625	11899.68737	12900
6.75	11075.49207	12900
6.875	10163.02432	12900
7	9173.318151	12900
7.125	8116.028382	12600
7.25	7179.727959	12900
7.375	6349.293214	12900
7.5	5611.490938	12600
7.625	4954.74207	12600
7.75	4368.914937	12600
7.875	3845.14432	12600
8	3375.673155	12300
8.125	2953.71401	12000
8.25	2826.796634	12000
8.375	2958.040805	12000
8.5	3315.176329	12000
8.625	3869.966788	11700
8.75	4597.705314	11700
8.875	5476.7734	11400
9	6488.25485	11400
9.125	7615.597994	11400
9.25	8432.273245	11400
9.375	8977.114089	11100
9.5	9284.099828	11100
9.625	9382.962349	10500
9.75	9299.717056	10800
9.875	9057.127424	10800
10	8675.111496	10200
10.125	8171.097559	10500
10.25	7699.819739	10500
10.375	7257.186022	10200
10.5	6839.615894	10200
10.625	6443.976407	9900
10.75	6067.526231	9900

Table H-16. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.125 days. Author's Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
10.875	5707.866702	9900
11	5362.89899	9900
11.125	5030.786616	9900
11.25	4697.907039	9600
11.375	4364.356159	9300
11.5	4030.217889	9600
11.625	3695.565653	9300
11.75	3360.463696	9600
11.875	3024.968234	9300
12	2689.128455	9300
12.125	2352.987398	9300
12.25	2058.863973	9000
12.375	1801.505977	9000
12.5	1576.31773	9000
12.625	1379.278013	9000
12.75	1206.868262	8700
12.875	1056.009729	9000
13	924.0085129	8700
13.125	808.5074488	8700
13.25	707.4440177	8700
13.375	619.0135155	8400
13.5	541.636826	8400
13.625	473.9322228	8400
13.75	414.6906949	8400
13.875	362.8543581	8400
14	317.4975633	8100
14.125	277.8103679	8100
14.25	243.0840719	7800
14.375	212.6985629	8100
14.5	186.1112426	8100
14.625	162.8473372	7800
14.75	142.4914201	7800
14.875	124.6799926	7800
15	109.0949935	7500
15.125	95.45811931	7500
15.25	83.5258544	7500
15.375	73.0851226	7200
15.5	63.94948227	7200
15.625	55.95579699	7200
15.75	48.96132237	7200
15.875	42.84115707	7200
16	37.48601244	7200
16.125	32.80026088	7200
16.25	28.70022827	7200
16.375	25.11269974	6600
16.5	21.97361227	6900
16.625	19.22691074	6900

Table H-17. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.125 days. Author's Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
16.75	16.82354689	6900
16.875	14.72060353	6600
17	12.88052809	6600
17.125	11.27046208	6600
17.25	9.86165432	6600
17.375	8.62894753	6600
17.5	7.550329089	6300
17.625	6.606537953	6300
17.75	5.780720708	6300
17.875	5.05813062	6300
18	4.425864292	6300
18.125	3.872631256	6300
18.25	3.388552349	6000
18.375	2.964983305	6000
18.5	2.594360392	6000
18.625	2.270065343	6000
18.75	1.986307175	6000
18.875	1.738018778	6000
19	1.520766431	6000
19.125	1.330670627	6000
19.25	1.164336799	6000
19.375	1.018794699	5700
19.5	0.891445362	5700
19.625	0.780014691	5700
19.75	0.682512855	5700
19.875	0.597198748	5700
20	0.522548905	5700
20.125	0.457230291	5400
20.25	0.400076505	5400
20.375	0.350066942	5700
20.5	0.306308574	5400
20.625	0.268020002	5400
20.75	0.234517502	5400
20.875	0.205202814	5100
21	0.179552463	5400
21.125	0.157108405	5400
21.25	6.496844854	5400
21.375	18.40348925	5100
21.5	35.18117809	5100
21.625	56.22103083	5100
21.75	80.99027698	5100
21.875	109.0227424	5100
22	139.9105246	4800
22.125	173.296709	4800
22.25	196.1502454	4800
22.375	209.7877147	5100
22.5	215.3611254	4800

Table H-18. "Shelter Incoming Rate" Results for a Simulation Run with the Integration Time Step=0.125 days. Author's Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
22.625	213.8784847	4800
22.75	206.2217991	4800
22.875	193.1628242	4800
23	175.3768462	4500
23.125	153.4547404	4500
23.25	134.2728979	4800
23.375	117.4887856	4800
23.5	102.8026874	4500
23.625	89.9523515	4500
23.75	78.70830756	4500
23.875	68.86976912	4800
24	60.26104798	4500
24.125	52.72841698	4500
24.25	46.13736486	4500
24.375	40.37019425	4200
24.5	35.32391997	4500
24.625	30.90842997	4500
24.75	27.04487623	4200
24.875	23.6642667	4200
25	20.70623336	4200
25.125	18.11795419	4200
25.25	15.85320992	4200
25.375	13.87155868	4200
25.5	12.13761384	3900
25.625	10.62041211	4200
25.75	9.292860598	4200
25.875	8.131253023	3900
26	7.114846395	4200
26.125	6.225490596	4200
26.25	6.525429271	3900
26.375	7.866000613	4200
26.5	10.11712554	3900
26.625	13.16498484	3900
26.75	16.90998674	3900
26.875	21.2649884	3600
27	26.15373985	3900

Table H-19. “Shelter Leaving” Rate Results for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
0	0	0
0.125	0	0
0.25	0	0
0.375	0	0
0.5	0	0
0.625	0	0
0.75	0	0
0.875	0	0
1	0	0
1.125	0	0
1.25	0	0
1.375	0	1
1.5	0	1
1.625	0	2
1.75	0	5
1.875	0	12
2	0	25
2.125	0	47
2.25	0	82
2.375	0	132
2.5	0	200
2.625	0.00E+00	290
2.75	0	403
2.875	0	543
3	0	710
3.125	0	906
3.25	0	1131
3.375	0	1385
3.5	0	1668
3.625	0	1977
3.75	0	2312
3.875	0	2668
4	0	3042
4.125	0	3431
4.25	134.625	3828
4.375	387.046875	4230
4.5	742.5410156	4630
4.625	1188.223389	5025
4.75	1712.820465	5408
4.875	2306.467907	5775
5	2960.534419	6122
5.125	3.67E+03	6445

Table H-20. “Shelter Leaving” Rate Results for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
5.25	4151.409164	6740
5.375	4440.233019	7006
5.5	4558.328891	7240
5.625	4527.03778	7441
5.75	4365.033057	7607
5.875	4088.653925	7737
6	3712.197185	7834
6.125	3248.172537	7897
6.25	2842.150969	7928
6.375	2486.882098	7929
6.5	2176.021836	7902
6.625	1904.019107	7849
6.75	1666.016718	7773
6.875	1457.764628	7676
7	1275.54405	7562
7.125	1116.101044	7435
7.25	1254.463413	7296
7.375	1653.405487	7151
7.5	2280.354801	7000
7.625	3106.810451	6848
7.75	4107.834144	6697
7.875	5261.604876	6550
8	6549.029267	6409
8.125	7953.400608	6275
8.25	8904.350532	6150
8.375	9458.556716	6036
8.5	9665.612126	5933
8.625	9568.910611	5842
8.75	9206.421784	5763
8.875	8611.369061	5695
9	7812.822929	5640
9.125	6836.220062	5596
9.25	5981.692555	5562
9.375	5233.980985	5538
9.5	4579.733362	5523
9.625	4007.266692	5515
9.75	3506.358355	5515
9.875	3068.063561	5520
10	2684.555616	5528
10.125	2348.986164	5540
10.25	2055.362893	5553
10.375	1798.442532	5566
10.5	1573.637215	5577
10.625	1376.932563	5587
10.75	1204.815993	5594
10.875	1054.213994	5597
11	922.4372446	5596

Table H-21. “Shelter Leaving” Rate Results for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
11.125	807.132589	5590
11.25	721.1941404	5578
11.375	660.9511228	5560
11.5	623.1916075	5537
11.625	605.1051565	5508
11.75	604.232637	5473
11.875	618.4223074	5432
12	645.7913939	5386
12.125	684.6924697	5336
12.25	779.621536	5280
12.375	923.575094	5222
12.5	1110.425082	5160
12.625	1334.809447	5095
12.75	1592.036391	5029
12.875	1878.000592	4962
13	2189.109893	4894
13.125	2522.221157	4826
13.25	2749.099762	4758
13.375	2883.024792	4692
13.5	2935.615443	4627
13.625	2917.038512	4565
13.75	2836.189948	4505
13.875	2700.853705	4448
14	2517.840742	4393
14.125	2293.110649	4342
14.25	2240.284318	4294
14.375	2337.873778	4250
14.5	2567.077056	4209
14.625	2911.442424	4171
14.75	3356.574621	4135
14.875	3889.877793	4103
15	4500.330569	4074
15.125	5178.289248	4047
15.25	5749.331217	4022
15.375	6226.821065	4000
15.5	6622.452807	3978
15.625	6946.458706	3958
15.75	7207.791993	3939
15.875	7414.286744	3919
16	7572.797776	3900
16.125	7689.323054	3880
16.25	7827.673297	3859
16.375	7985.120385	3838
16.5	8159.277212	3817
16.625	8348.05506	3795
16.75	8549.626303	3772
16.875	8762.391765	3748

Table H-22. “Shelter Leaving” Rate Results for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
17	8984.952169	3723
17.125	9216.083148	3698
17.25	9253.604005	3671
17.375	9121.716004	3643
17.5	8841.595254	3615
17.625	8431.770847	3585
17.75	7908.455741	3555
17.875	7285.836273	3523
18	6576.325489	3491
18.125	5790.784803	3459
18.25	5153.233578	3426
18.375	4645.17313	3392
18.5	4250.417114	3359
18.625	3954.802475	3325
18.75	3745.936541	3291
18.875	3612.975723	3258
19	3546.431883	3224
19.125	3538.002897	3191
19.25	3539.86191	3159
19.375	3550.722921	3128
19.5	3569.460681	3098
19.625	3595.090596	3069
19.75	3626.751147	3042
19.875	3663.688503	3016
20	3705.243065	2991
20.125	3750.837682	2967
20.25	3742.295472	2945
20.375	3686.383538	2924
20.5	3589.023096	2904
20.625	3455.395209	2885
20.75	3290.033308	2867
20.875	3096.904144	2850
21	2879.478626	2834
21.125	2640.793798	2818
21.25	2416.788323	2803
21.375	2205.627283	2788
21.5	2005.705122	2774
21.625	1815.616982	2760
21.75	1634.133609	2746
21.875	1460.179408	2732
22	1292.813232	2719
22.125	1131.211578	2705
22.25	1036.435131	2691
22.375	1000.13074	2677
22.5	1014.989397	2662
22.625	1074.615722	2646
22.75	1173.413757	2630

Table H-23. “Shelter Leaving” Rate Results for a Simulation Run with the Integration Time Step=0.125 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
22.875	1306.487037	2613
23	1469.551158	2595
23.125	1658.857263	2577
23.25	1830.687605	2559
23.375	1987.226655	2540
23.5	2130.385823	2520
23.625	2261.837595	2500
23.75	2383.045396	2480
23.875	2495.289721	2459
24	2599.691006	2439
24.125	2697.22963	2418
24.25	2732.029051	2398
24.375	2711.93167	2378
24.5	2643.799586	2358
24.625	2533.637138	2339
24.75	2386.698121	2321
24.875	2207.579606	2303
25	2000.30403	2286
25.125	1768.391026	2270
25.25	1566.842148	2254
25.375	1391.861879	2238
25.5	1240.129145	2223
25.625	1108.738001	2208
25.75	995.1457513	2193
25.875	897.1275323	2179
26	812.7365908	2165
26.125	740.269517	2151
26.25	673.2202023	2137
26.375	610.911427	2124
26.5	552.7506237	2111
26.625	498.2192957	2099
26.75	446.8637587	2087
26.875	398.2870389	2075
27	352.141784	2064

Time Step: 0.25 Days

Table H-24. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.25 days. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
0	1315	0
0.25	1315	0
0.5	1315	0
0.75	1315	0
1	1315	0
1.25	1315	300
1.5	3295.875	1500
1.75	6762.40625	3900
2	11343.17969	5700
2.25	16759.63477	7500
2.5	19063.47607	9300
2.75	19032.85706	10500
3	17251.39279	11700
3.25	14156.79459	12900
3.5	15287.40845	12900
3.75	19586.93133	12900
4	26263.136	12900
4.25	34721.852	12900
4.5	37309.764	12600
4.75	35494.573	12900
5	30377.05475	12600
5.25	2.28E+04	12600
5.5	17896.9683	12900
5.75	15042.47622	12900
6	13711.48217	13200
6.25	13523.11163	13200
6.5	12616.64622	13200
6.75	11171.60966	13200
7	9322.644748	13200
7.25	7170.733561	13200
7.5	5512.112671	13200
7.75	4223.459503	12600
8	3212.282127	12600
8.25	2409.211596	12600
8.5	2776.096197	12600
8.75	4020.447147	12000
9	5922.897861	11400
9.25	8318.923395	11400
9.5	9436.942547	10800
9.75	9596.45691	10800
10	9037.092682	10500

Table H-25. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.25 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
10.25	7.94E+03	10500
10.5	6993.614634	10200
10.75	6163.835975	9900
11	5420.439482	9600
11.25	4741.829611	9900
11.5	4063.747208	9900
11.75	3386.060406	9300
12	2708.670305	9300
12.25	2031.502729	9300
12.5	1523.627046	9300
12.75	1142.720285	9000
13	857.0402136	9300
13.25	642.7801602	9000
13.5	482.0851202	8700
13.75	361.5638401	8400
14	271.1728801	8100
14.25	203.3796601	8100
14.5	152.534745	8100
14.75	114.4010588	7800
15	85.80079409	7800
15.25	64.35059557	7500
15.5	48.26294668	7200
15.75	36.19721001	7500
16	27.1479075	7200
16.25	20.36093063	6900
16.5	15.27069797	6900
16.75	11.45302348	6900
17	8.589767609	6600
17.25	6.442325707	6600
17.5	4.83174428	6600
17.75	3.62380821	6300
18	2.717856158	6300
18.25	2.038392118	6300
18.5	1.528794089	6300
18.75	1.146595566	6300
19	0.859946675	6000
19.25	0.644960006	6000
19.5	0.483720005	6000
19.75	0.362790003	6000
20	0.272092503	5700
20.25	0.204069377	5700
20.5	0.153052033	5100
20.75	0.114789025	5400
21	0.086091768	5400
21.25	0.064568826	5400
21.5	25.48592662	5100
21.75	69.98944496	5100

Table H-26. “Shelter Incoming Rate” Results for a Simulation Run with the Integration Time Step=0.25 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Incoming Rate	Simulation: Shelter Incoming Rate
22	128.8045837	4800
22.25	198.3534378	5100
22.5	225.0775783	5100
22.75	219.6831838	4800
23	190.1998878	4800
23.25	142.6499159	4800
23.5	106.9874369	4500
23.75	80.24057767	4500
24	60.18043326	4800
24.25	45.13532494	4500
24.5	33.85149371	4500
24.75	25.38862028	4500
25	19.04146521	4200
25.25	14.28109891	4200
25.5	10.71082418	4200
25.75	8.033118135	4200
26	6.024838601	3900
26.25	4.518628951	4200
26.5	7.701471713	3900
26.75	14.40110379	3900
27	23.73832784	3900

Table H-27. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.25 days. Author’s Elaboration, 2008.

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
0	0	0
0.25	0	0
0.5	0	0
0.75	0	0
1	0	0
1.25	0	0
1.5	0	1
1.75	0	1
2	0	4
2.25	0	23
2.5	0	85
2.75	0	224
3	0	469
3.25	0	843
3.5	0	1359
3.75	0	2014
4	0	2796
4.25	0	3674
4.5	538.5	4602
4.75	1480.875	5529
5	2726.15625	6406
5.25	4.20E+03	7181
5.5	4764.462891	7818
5.75	4650.347168	8287
6	4026.260376	8573
6.25	3019.695282	8674
6.5	2264.771461	8603
6.75	1698.578596	8385
7	1273.933947	8051
7.25	955.4504603	7637
7.5	1828.087845	7181
7.75	3594.065884	6718
8	6030.049413	6284
8.25	8968.53706	5906
8.5	10060.90279	5601
8.75	9768.677096	5381
9	8438.007822	5251
9.25	6328.505867	5210
9.5	4746.3794	5247
9.75	3559.78455	5341
10	2669.838412	5474
10.25	2.00E+03	5622
10.5	1501.784107	5765

Table H-28. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.25 days. Author’s Elaboration, 2008 (Continued).

Days	KATRINA SMOOTH Shelter Leaving Rate	Simulation: Shelter Leaving Rate
10.75	1126.33808	5884
11	844.7535602	5967
11.25	633.5651701	6004
11.5	534.9863776	5988
11.75	520.8647832	5915
12	570.0860874	5792
12.25	666.8145656	5629
12.5	982.9234242	5432
12.75	1463.567568	5213
13	2067.613176	4985
13.25	2764.209882	4761
13.5	3028.282412	4552
13.75	2967.961809	4370
14	2664.346357	4222
14.25	2178.259767	4110
14.5	2388.944826	4032
14.75	3122.208619	3983
15	4247.406464	3959
15.25	5666.554848	3955
15.5	6642.228636	3963
15.75	7285.296477	3978
16	7678.909858	3992
16.25	7885.432393	3997
16.5	8185.886795	3992
16.75	8556.790096	3972
17	8980.530072	3935
17.25	9443.897554	3880
17.5	9132.548166	3809
17.75	8240.161124	3723
18	6911.995843	3625
18.25	5256.996882	3521
18.5	4214.935162	3414
18.75	3632.576371	3307
19	3394.994779	3205
19.25	3415.996084	3114
19.5	3468.684563	3037
19.75	3545.138422	2974
20	3639.416317	2926
20.25	3747.062237	2893
20.5	3634.046678	2874
20.75	3355.535009	2866
21	2952.901256	2865
21.25	2457.175942	2864
21.5	2024.756957	2859
21.75	1639.817718	2849
22	1290.488288	2834
22.25	967.8662161	2812

Table H-29. “Shelter Leaving Rate” Results for a Simulation Run with the Integration Time Step=0.25 days. Author’s Elaboration, 2008 (Continued).

Days	**KATRINA SMOOTH Shelter Leaving Rate**	**Simulation: Shelter Leaving Rate**
22.5	912.3996621	2781
22.75	1057.299747	2739
23	1352.47481	2691
23.25	1760.356107	2638
23.5	2091.017081	2582
23.75	2363.76281	2525
24	2593.072108	2468
24.25	2789.804081	2413
24.5	2735.165561	2359
24.75	2491.99917	2311
25	2107.436878	2269
25.25	1616.827658	2234
25.5	1254.370744	2207
25.75	988.0280579	2185
26	793.7710434	2166
26.25	653.5782825	2150
26.5	533.8712119	2136
26.75	429.5284089	2121
27	336.7088067	2105

Appendix I – Simulation Results for Scenarios: Hypothesis 1

Meals Scenario:

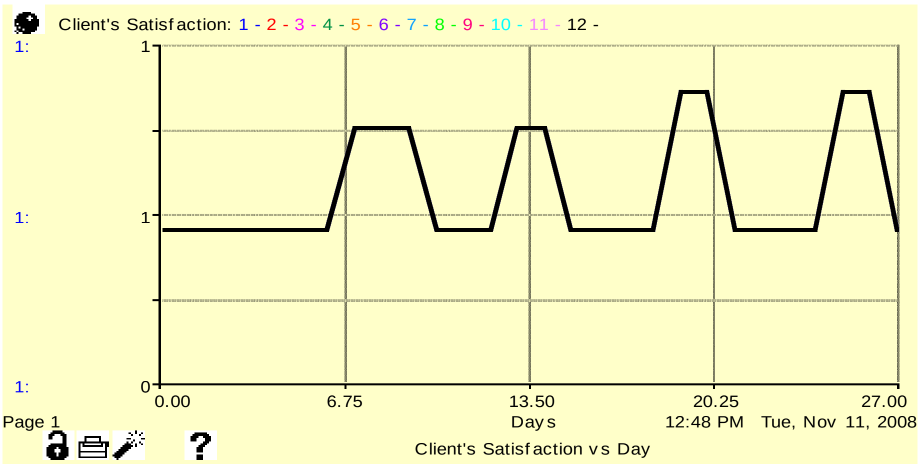


Figure I-1. "Client's Satisfaction": Increments in Meals Scenario. Author's Elaboration, 2008.

Table I-1. "Client's Satisfaction": Increments in Meals Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Meals Scenario										
		Value with Increment of 5%	Value with Increment of 10%	Value with Increment of 15%	Value with Increment of 20%	Value with Increment of 25%	Value with Increment of 50%	Value with Increment of 75%	Value with Increment of 80%	Value with Increment of 85%	Value with Increment of 90%	Value with Increment of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12

Financial Assistance Scenario:

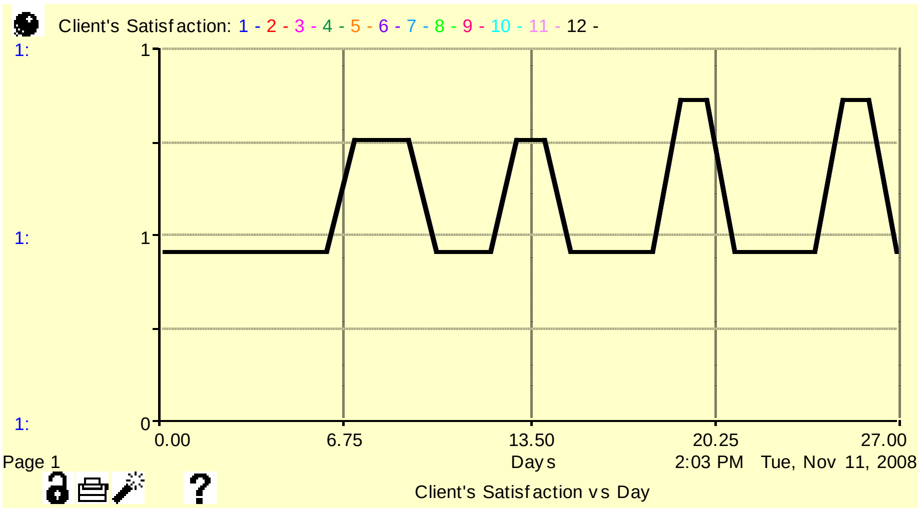


Figure I-2. "Client's Satisfaction": Increments in Financial Assistance Scenario. Author's Elaboration, 2008.

Table I-2. "Client's Satisfaction": Increments in Financial Assistance Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Financial Assistance Scenario										
		Value with Increment of 5%	Value with Increment of 10%	Value with Increment of 15%	Value with Increment of 20%	Value with Increment of 25%	Value with Increment of 50%	Value with Increment of 75%	Value with Increment of 80%	Value with Increment of 85%	Value with Increment of 90%	Value with Increment of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12

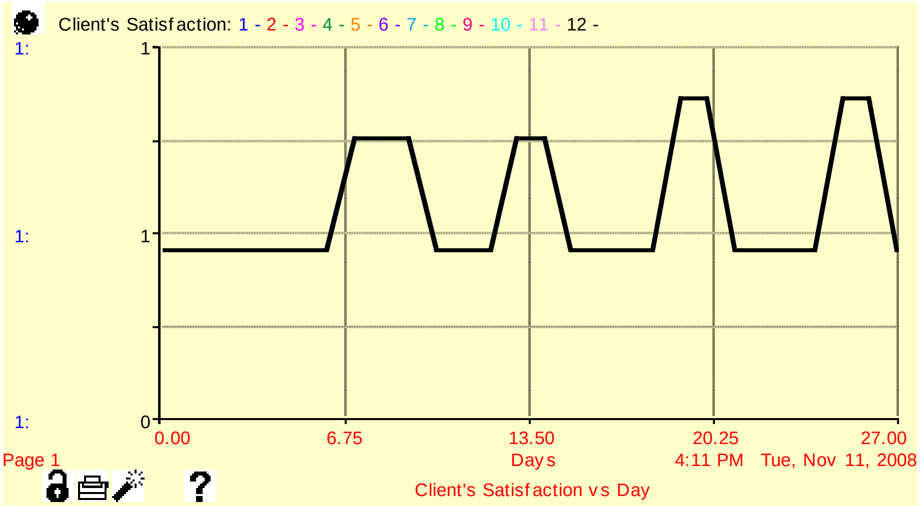


Figure I-3. "Client's Satisfaction": Reductions in Financial Assistance Scenario. Author's Elaboration, 2008.

Table I-3. "Client's Satisfaction": Reductions in Financial Assistance Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Financial Assistance Scenario										
		Value with Reduction of 5%	Value with Reduction of 10%	Value with Reduction of 15%	Value with Reduction of 20%	Value with Reduction of 25%	Value with Reduction of 50%	Value with Reduction of 75%	Value with Reduction of 80%	Value with Reduction of 85%	Value with Reduction of 90%	Value with Reduction of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12

Mental Health Care Scenario:

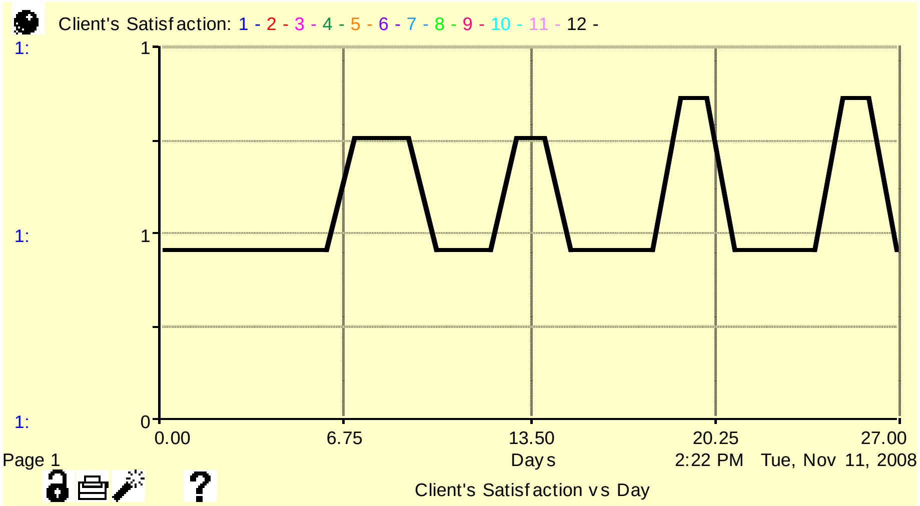


Figure I-4. "Client's Satisfaction": Increments in Mental Health Care Scenario. Author's Elaboration, 2008.

Table I-4. "Client's Satisfaction": Increments in Mental Health Care Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Mental Health Care Scenario										
		Value with Increment of 5%	Value with Increment of 10%	Value with Increment of 15%	Value with Increment of 20%	Value with Increment of 25%	Value with Increment of 50%	Value with Increment of 75%	Value with Increment of 80%	Value with Increment of 85%	Value with Increment of 90%	Value with Increment of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545

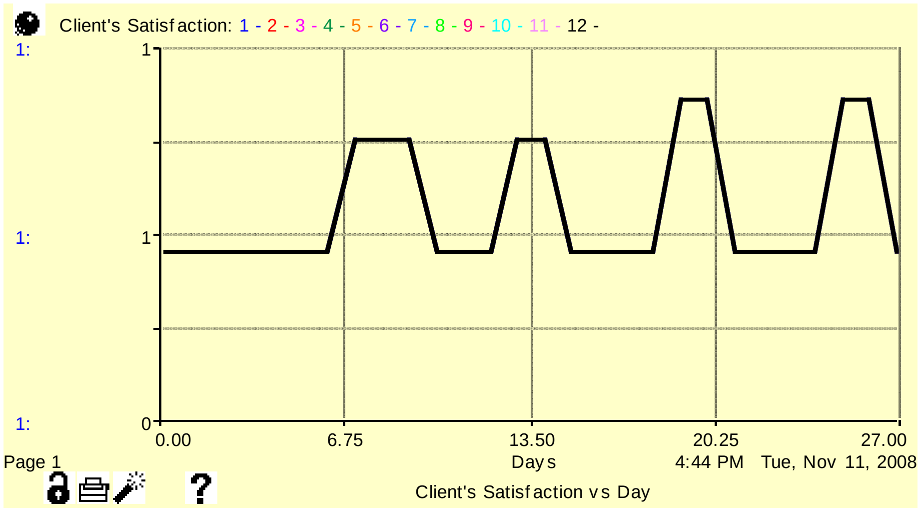


Figure I-5. "Client's Satisfaction": Reductions in Mental Health Care Scenario. Author's Elaboration, 2008.

Table I-5. "Client's Satisfaction": Reductions in Mental Health Care Scenario. Author's Elaboration, 2008.

Days	Baseline Scenario	Mental Health Care Scenario										
		Value with Reduction of 5%	Value with Reduction of 10%	Value with Reduction of 15%	Value with Reduction of 20%	Value with Reduction of 25%	Value with Reduction of 50%	Value with Reduction of 75%	Value with Reduction of 80%	Value with Reduction of 85%	Value with Reduction of 90%	Value with Reduction of 95%
0	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
1	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
2	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
3	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
4	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
5	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
6	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
7	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
8	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
9	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
10	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
11	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
12	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
13	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
14	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586	0.7586
15	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
16	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
17	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
18	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
19	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
20	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
21	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
22	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
23	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
24	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545
25	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
26	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658	0.8658
27	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545	0.4545

Appendix J – Rita Reference Modes

Data available for Louisiana, Mississippi and Texas Zone.

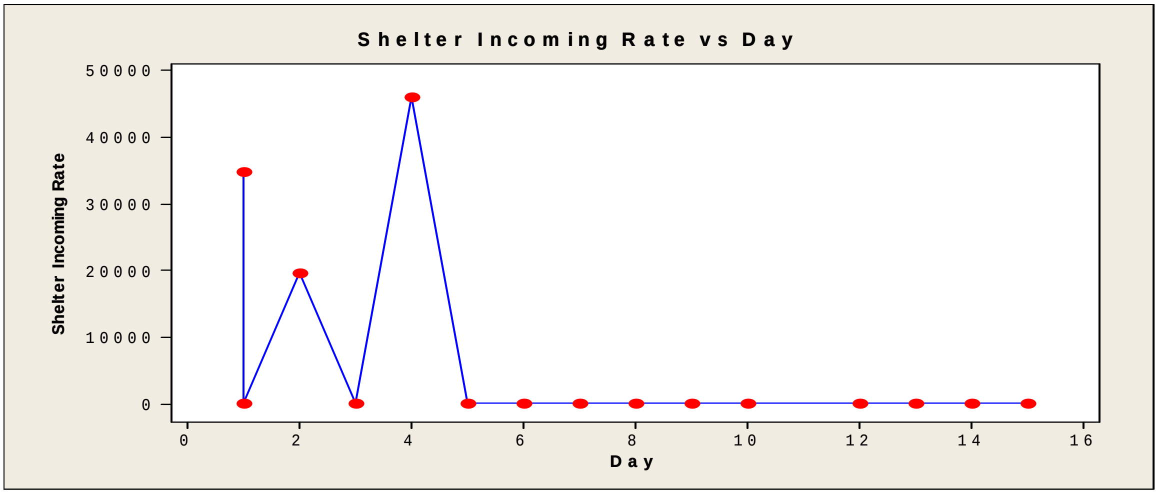


Figure L-1. “Shelter Incoming Rate” during Rita Operation. Author’s Elaboration, 2008.

It is clearly visible the large fluctuation with peaks appearing around the 1st and 4th day. “Shelter Incoming Rate” has ranged from 0 to nearly 45,931 people. This reference mode follows mostly a constant behavior with specific deviations.

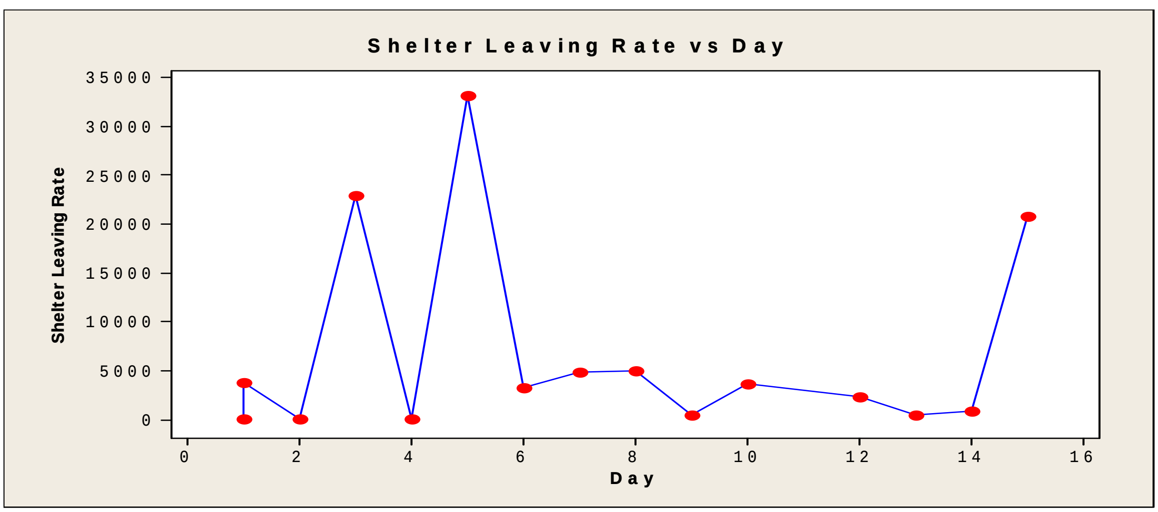


Figure L-2. “Shelter Leaving Rate” during Rita Operation. Author’s Elaboration, 2008.

It is clearly visible the large fluctuation with peaks appearing around the 3rd and 5th day. “Shelter Leaving Rate” has ranged from 0 to nearly 33,100 people. This reference mode follows a chaotic oscillations behavior (Sterman 2000).

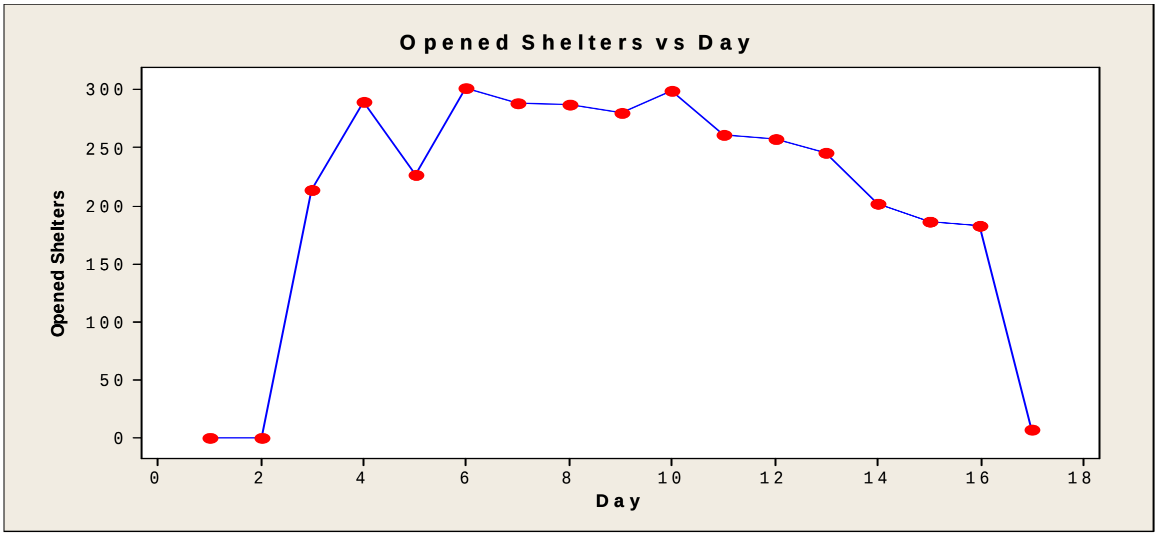


Figure L-3. “Opened Shelters” during Rita Operation. Author’s Elaboration, 2008.

It is clearly visible the large fluctuation with peaks appearing around the 6th and 10th day. “Opened Shelters” have ranged from 0 to nearly 301 shelters. This reference mode exhibits a pure negative exponential goal-seeking (also called exponential decay) behavior (Sterman 2000).

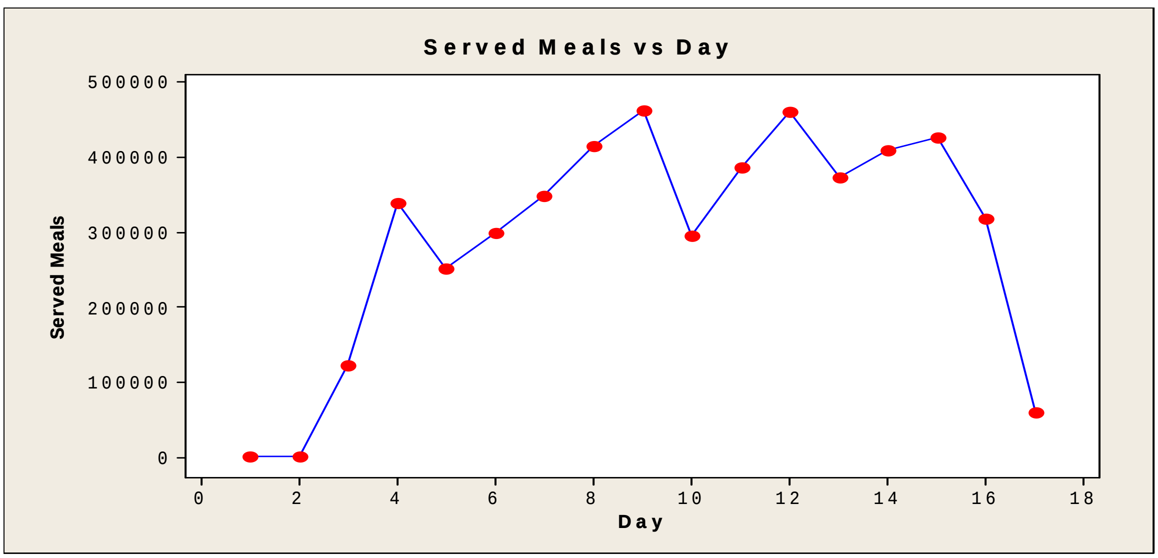


Figure L-4. “Served Meals” during Rita Operation. Author’s Elaboration, 2008.

It is clearly visible the large fluctuation with peaks appearing around the 9th and 12th day. “Served Meals” have ranged from 0 to nearly 461,599 meals. This reference mode follows a chaotic oscillations behavior (Sterman 2000).

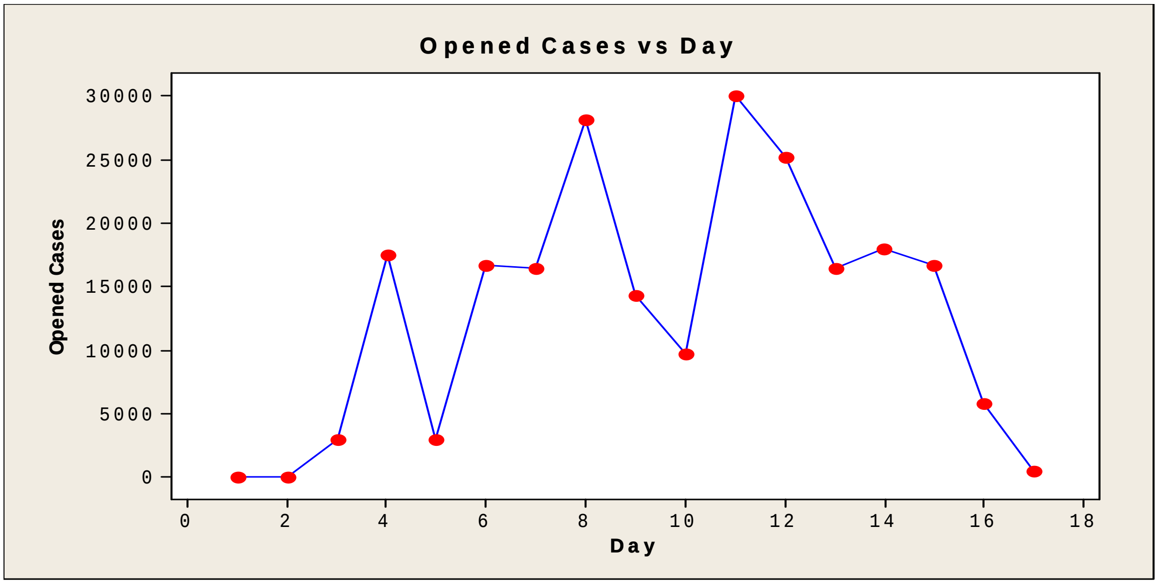


Figure L-5. "Opened Cases" during Rita Operation. Author's Elaboration, 2008.

It is clearly visible the large fluctuation with peaks appearing around the 1st and 11th day. "Opened Cases" have ranged from 0 to nearly 29,994 cases. This reference mode follows a chaotic oscillations behavior (Sterman 2000).

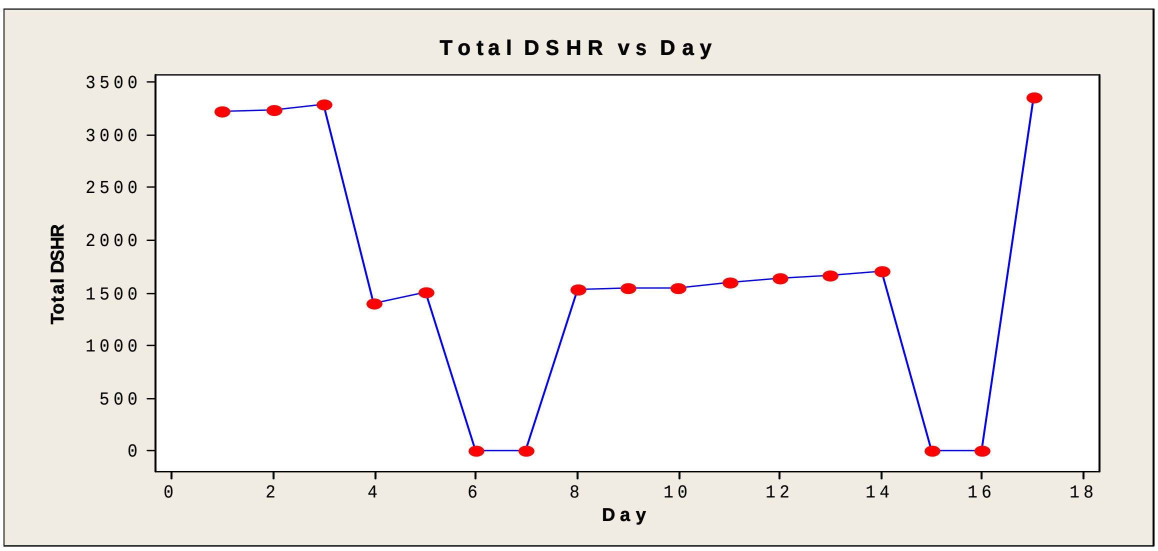


Figure L-6. "DSHR Capacity" during Rita Operation. Author's Elaboration, 2008.

It is clearly visible the large fluctuation with peaks appearing around the 3rd and 17th day. "DSHR Capacity" has ranged from 0 to nearly 3351 people. This reference mode follows an overshoot and collapse behavior (Sterman 2000).

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