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Providing Business Continuity Plan after Natural Disasters: A Case Study in the Staff Area of Water and Wastewater Company of Tehran

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ABSTRACT

Introduction: Each economic and non-economic institute is inevitably forced to pay special attention to the post-crisis phase to keep its organizational alive, carry out its missions, and reduce the damages and costs caused by various crises. In this research, we tried to extract the Business Continuity Plan (BCP) after the natural disaster of earthquake in the staff area of Water and Wastewater Company of Tehran within the localized framework of BS-25999 British Standards Institution (BSI).

Methods: In this regard, a questionnaire was used for data collection. Analysis of the questionnaire results was performed by SPSS19 and Expertchoice11 applications.

Results: The manager of Water and Wastewater Company of Tehran was found to be the best authority for managing the emergency so that the company can continue its operation and return to normal situation. According to the findings, the hot site was selected as the best location for business continuity of Water and Wastewater Company of Tehran, which could be an alternative site to continue the activities and services after the disaster.

Conclusion: A localized post-earthquake Business Continuity Plan (BCP) was suggested in the staff area of Water and Wastewater Company of Tehran. In this site, necessary actions can be perfromed to continue the activities before, during, and after the disaster. Furthermore, organizational chart and task description can be redefined in it.

Keywords: Standard BS-25999, Business Continuity Plan (BCP), staff area of Water and Wastewater Company of Tehran.

Introduction

Every organization is subjected to the danger of potential events, such as natural disasters (floods, earthquakes, and etc.) and environmental disasters (pollution and leakage of dangerous materials). In this regard, providing and keeping a Business Continuity Plan (BCP) helps the organization to ensure about possession of the required resources and data to confront with these emergency conditions (1).

In 2007, British Standards Institution (BSI) formulated BS-25999 standard called " Business Continuity Management (BCM)". The first approach of this standard is to prepare organizations and companies to confront various kinds of crises. This standard, as the first standard of management

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of business continuity, creats an appropriate management system and tries to help the organization to continue working even in the most unpredicted severe conditions. In this way, it reduces the risk of failure, supports the prosperity and security of staff as well as validity of the organization, and provides the ability to guide and continue main activities. This standard was published in two parts late in 2006 and early in 2007 (2):

1- The first part of **BS-25999** is introduced as a manual and expresses how to make a business continuity management process. It also provides examples and appropriate suggestions. Generally, it is a standard that:

A. Makes processes, rules, and related terms to BCM.

B. Provides an introduction for implementation and measurement of the durability of Business Continuity in the organization.

C. Can be executed and implemented in various organizational scales.

2- The second part of **BS-25999**, which contains the specifications and features of the management schema, contains the needed requirements for implementation, execution, and advancement of a business continuity management system (BCMS). This part enables the organization to validate and formalize arrangements of the business continuity management by an external audit. In other words, they can have an independent audit for this purpose. It makes shareholders, clients, and insurance agencies more assured about management process of the business continuity in the mentioned organization.

The main purpose of the standard is to offer basic concepts for understanding, making, and implementing business continuity in an organization. Additionally, it looks for assurance of organization relations with its clients and other organizations. This standard enables the organization to evaluate and measure the management ability of the business continuity through an integrated and predefined method. The defined needs and requirements in British Standard are general. It is expected that regardless of the type, size, and nature of the business, it should be applicable in all organizations (or at least parts of them).

The Water and Wastewater Company has the responsibility of supplying and keeping water as an essential element of life. Therefore, continuation of its activities is of great importance in disaster time. If this organization can keep on its regular operation in emergency conditions, the society can return to normal situation more rapidly. So, it is necessary to plan for the continuity of activities in critical conditions before the disaster happens.

Shimoda reported an integrated set of necessary data on security issues in urban water and wastewater system, which was the consequence of broad research in the United States. This research was presented as a source on security issues of water and wastewater system for a wide range of catastrophic factors (3).

Mozaffari also considered the vulnerability of water supply systems against earthquakes and examines solutions for crisis management in this system (4).

After examining the research background, the theoretical foundations of BCP in the crisis management system is addressed in this paper. In the case study section, the general specifications of Tehran and Water and Wastewater Company of Tehran province are studied and then, research methodology is described. Finally, the results were presented.

Theoretical Foundations

In this section, to clarify the theoretical foundations of the research, three topics were focoused on: the place of BCP in crisis management cycle, the life cycle of business continuity, Plan-Do-Check-Act, which are used in research and formulation of the plan.

The Place of BCP in Crisis Management Cycle

The initial goal of crisis management is to avoid casualties and losses of life caused by the crisis and being prepared to deal with them. Then, in the case of a crisis, the aim is to make a quick relief and reduce the effects and consequences of the crisis. One of the critical parts of the crisis management

cycle is the recovery and improvement after the disaster. Business Continuity Plan can be considered as a pass from the response to the recovery phase of disaster cycle **(Figure 1)**. This planning should initiate immediately after occurance of a disaster in an organization and should be continued until beginning of the complete renovation and recovery plans.

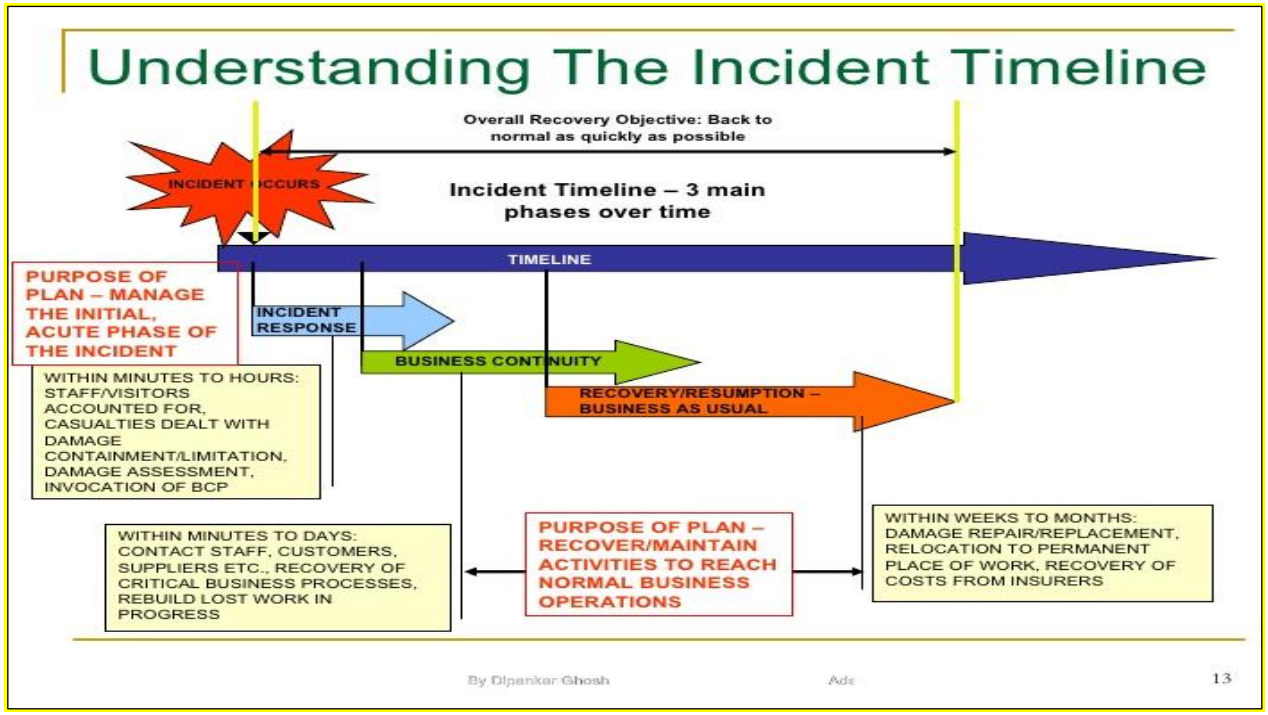

Figure 1. The relationship between Disaster Management, Business Continuity Management, and Business Recovery(5)

The Life Cycle of BCP

As **Figure 2** shows, the life cycle of BCM comprises of Six sections (Understanding the Organization, Determining BCM Strategies, Developing and Implementing a BCM Response, Exercising, Maintenance and Reviewing). These parts can be implemented at any organization with any size. It should be considered that the type of organization (public or private) does not have any effect on the elements of this cycle. Although the prospect and structure of the BCM program and also the amount of follow up and investment can differ with regard to conditions of every organization, all of these parts should be performed. The scope and structure of this program can be varied and activities can be extended according to the particular needs of each complex, yet the main phases of the cycle **(Figure 2)** are necessary (6) .

Figure 2. Business Continuity Lifecycle (6)

Plan, Do, Check, and Act Models

The BS-25999 standard uses the Plan-Do-Check-Act (PDCA) model to make, implement, operate and execute, check, practice, maintain, and activate development of a business continuity management system of an organization. This guarantees a level of consistency with other standards of management systems, including ISO 9001: 2000 (Quality Management Systems), ISO 14001: 1996 (Environmental Management Systems), ISO 27001: 2005 (Information Security Management Systems) and ISO 20000-2: 2005 (IT Service Management). **Figure 3** indicates how the business continuity management system does the business continuity by receiving the needs and expectations from various groups and produces business continuity results, which meets all those expectations and requirements by doing necessary activities and processes.

Plan: plans are required to create business continuity policies, goals, processes, and procedures related to risk management and development of business continuity in order to achieve results consistent with policies and general missions of the organization.

Do: it includes implementing and executing the Business Continuity policies, controls, processes, and procedures.

Check: it contains checking the efficiency and review of missions and Business Continuity policies, reporting the results to the management for review, and defining the activities for correction and development.

Act: this is act of business continuity management system by taking appropriate and preventive measures based on the consequences of managerial reviews to make a continuous development in the Business Continuity Management System (BCMS) as well as policies and objectives of the Business Continuity.

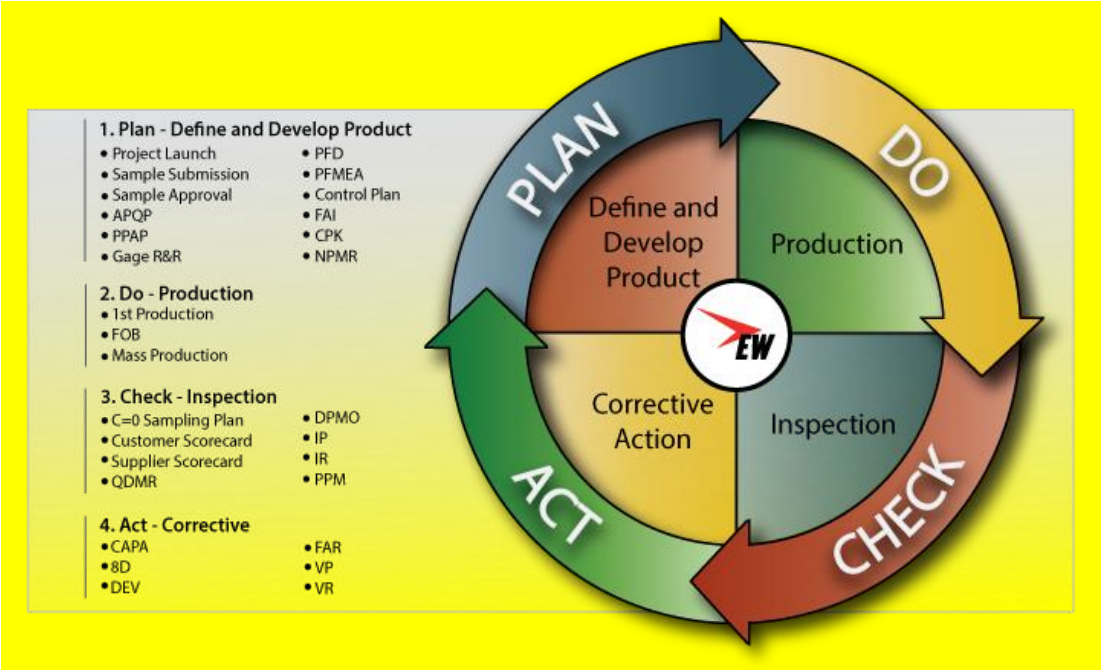

Figure 3. PDCA cycle used in Business Continuity management system processes (7)

Case Study

Following the case study of this research, which is focused on Water and Wastewater Company of Tehran (WWCT), this section presents the geographic specifications and seismicity of the activity area of Water and Wastewater Company of Tehran as well as general profile of the organization and its central veins.

General Specifications of Tehran City

Tehran is the largest city and capital of Iran and the provintial capital of Tehran. Based on the last census, its population is 13,267,637 and is the eighteenth biggest city in the world (8). The area of this city is 730 km^2. It has a full system of highways and 5 active subway lines. The population density in Tehran is estimated between 10700 to more than 11000 individuals per each square kilometer (9). Height of the city in the highest places of north reaches to 2000 meters and in the southern parts reaches to 1050 meters above ocean level. From the north, Tehran reaches to the mountain areas and from the south to the deserted regions. Hence, it has various climate conditions in the south and north. The northern parts have cold and dry weather, while the southern districts have warm and dry weather. Tehran is separated into 22 districts, 134 regions and 370 neighborhoods (10).

Tehran province includes around 1.2 percent of the country area and it's population is 92% of the urban population and 20 percent of the country's population. Regarding to country divisions, Tehran province has 13 cities and 54 towns. From technical perspective, around 44% of the country's industries are located in Tehran province. Moreover, location of the political and critical centers of country in this province has doubled the significance and importance of the organization's responsibility in doing the serving tasks.

The Situation of Tehran's seismicity and vulnerability against earthquake

Alborz region and particularly Tehran is considered as hazardous regions in terms of seismicity. This implies that destruction power and danger threshold is very high in Alborz area. Consequently, the frequency of quakes is low in them. In other words, the quantity of occured earthquakes in a region like Tehran in a period of 100 years is low, but after a period of 100 or 200 years, a great earthquake happens in it, because during the years, small quakes can prevent occurrence of large earthquakes of 7 to 8 Richter

magnitude scale in a district. According to the occurred earthquakes in Tehran and its around areas, experts predict the recurrence interval of significant earthquakes in Tehran about 150 to 200 years. The last significant earthquake with more than 7 Richter in Tehran district happened in 1830, which was related to the North fault of Tehran. Therefore, an earthquake of over 7 Richter is not unexpected in Tehran (National Geosciences Database of Iran; International Institute of Earthquake Engineering and Seismology (11).

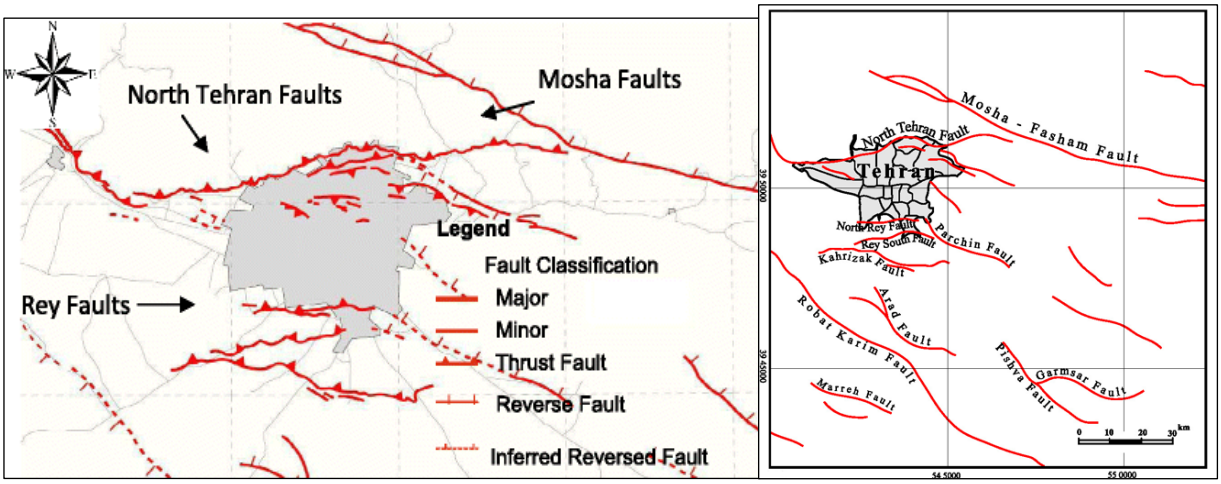

Figure 4. Fault Map of Tehran (11-14)

Tehran region and its surrounded plains are considered as complex fault regions. Generally, faults include the reverse fault of Ahar, the landslide of the north of Tehran, reverse fault of Imam Zadeh Davoud, Puorkan-Vardij landslide, Kahrizak fault, Niyavaran landslide, Mahmoudieh fault, Shaban Kousar fault, North of Rey fault, and South of Rey fault.

Generally, according to the estimation of seismology and crisis management experts, the most vulnerability of Tehran is imposed by the north fault and faults of Rey, so its magnitude is estimated to be 8 to 9 Richter in the case of shaking, which can influence the strongest structures. According to **figure 5**, it can be observed that a large portion of the districts 9, 10, 11, 12, 15, 16, 17, 18, 19, 20 have the magnitude of 9 MM and will experience the most damage in the case of "Rey fault" activation. The earthquake magnitude in other districts of Tehran mainly will be 8 Richter. In some parts of the northeast and northwest, the magnitude of the earthquake will be 7 (VII); the main reason for reduction of magnitude in these districts is their distance from the fault (National Geosciences Database of Iran; International Institute of Earthquake Engineering and Seismology) (11).

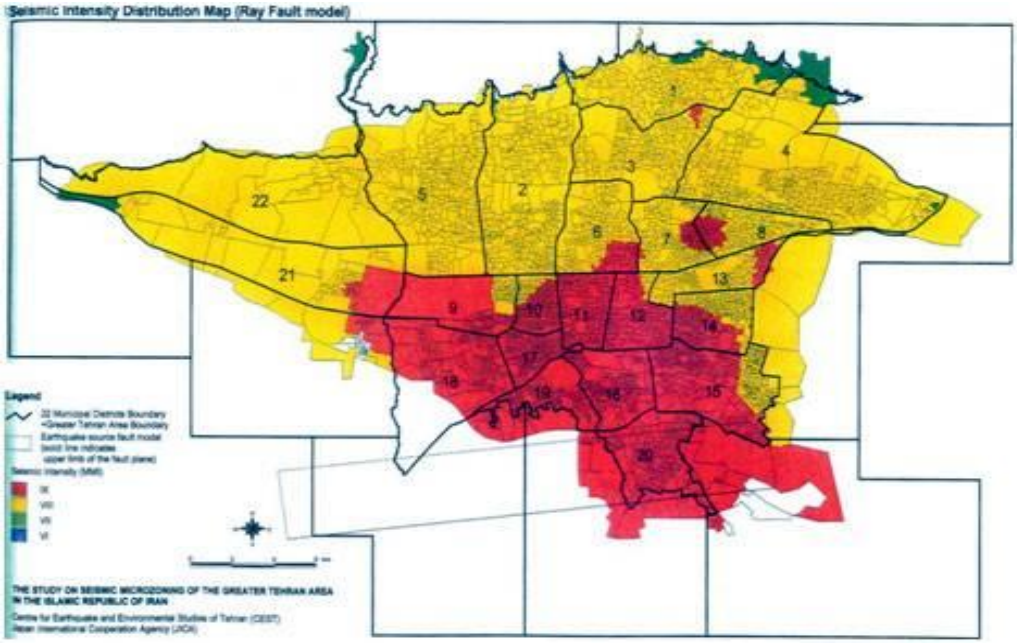

Figure 5. Earthquake Severity Dispersion Map- Rey Fault Model

Water and Wastewater Company of Tehran Province

WWCT is in charge of distribution of drinking and clean water and also disposal of urban sewage from the districts of Tehran province. WWCT does the assigned task through subsidiary companies, which include six water and wastewater companies in districts of one to six of Tehran: Supply and Treatment Company of Tehran Water and Wastewater, Tehran Wastewater Company, Cities and Township Company of West of Tehran, Water and Wastewater Company of Southwest of Tehran, Water and Wastewater Company of Southeast of Tehran Province, Water and Wastewater Company of East of Tehran Province, and Tehran Pipe Mills Company. This organization has a total of 5150 permanent and settled term employees and utilizes the services of 2,600 staff in the format of service companies (WWCT website).

The purpose of this company is to make and utilize the supply and transfer drinkable clean water installations and to make and utilize related installations to transfer water as well as to treat and transfer wastewater within the framework of criteria and policies of Tehran province Water and Wastewater Company, Engineering company of the Water and Wastewater and the Ministry of Energy. The main center of the company is located in Tehran, and its operating area includes Tehran, Shemiranat, and Shahre-e-Rey. The water supply installations of Tehran and its transmission lines are about 50 years old. These installations have 568 km transmission line, 9200 km distribution network in an area of 50,000 hectares, 100,000 network valves, 530 pressure reducing valves, 35 pumping stations, and 58 tanks with the capacity of 1,713,200 cubic meters of water reserving (WWCT Website).

Vulnerability of Life Lines of Tehran Water and Wastewater against Earthquake

Water Life lines are divided into two main groups, including control centers and communication lines. Control centers include installations such as water treatment plants and subsidiary distribution centers, and connectors (connecting installations) are equipment such as pipes for supply and distributions purposes. The city of Tehran has five working plants which general specifications are provided in **Table 1**:

Table 1. Tehran Water treatment centers (WWCT website)

Row	Name of the water treatment plant	Operational year	Source of water supply	Location in Tehran	Special characteristic
1	No. 1 water treatment plant (Jalaliyeh)	1955	Karaj River and Taleghan Dam	Fatemi Street (Tehran Center)	One of the oldest water treatment centers of Iran
2	No. 2 water treatment plant (Kan)	1963 and 1970	Karaj River and Taleghan Dam	West of Tehran (Shahr-e- Ziba)	Iran's largest water treatment plant
3 and 4	No. 3 and 4 water treatment plants (Tehranpars)	No. 3 water treatment plant in 1964 and No. 4 in 1984	Latyan Dam	Northeast of Tehran on Shahid Abbaspour Blvd	Providing the water of east and parts of the north, center, and south of Tehran
5	Number 5 water treatment plant (Jajrood)	2004	Lar Dam	Northeast of Tehran City	Equipped to the best technology of process control

In **diagrams 1, 2, 3, and 4**, the vulnerability of pipelines was indicated according to the studies conducted by the Japan International Cooperation Agency (JICA) in Tehran (15).

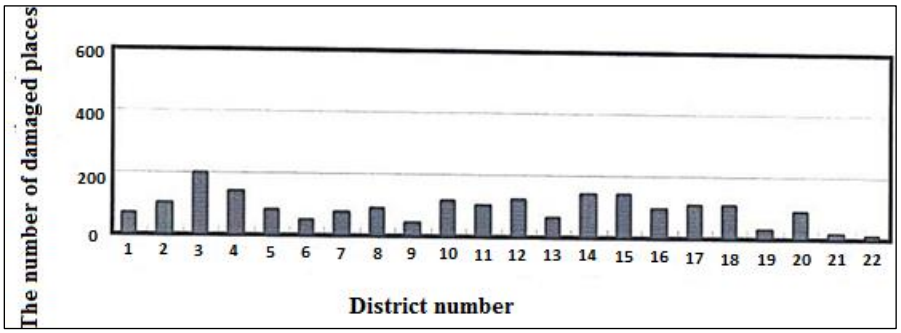

Diagram 1. The vulnerability of water supply pipelines in different districts of Tehran based on the floating model

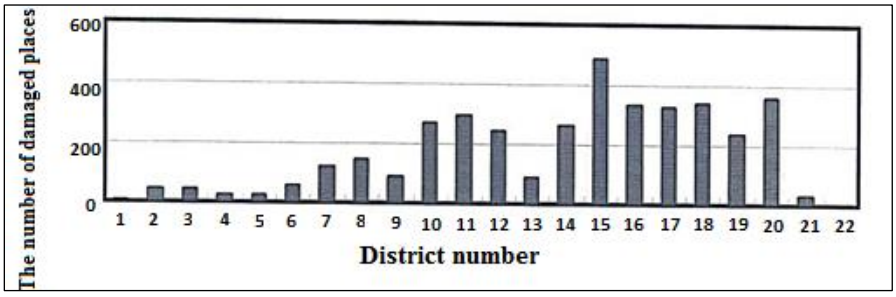

Diagram 2. The Vulnerability of water supply pipelines in different areas of Tehran based on Ray fault model

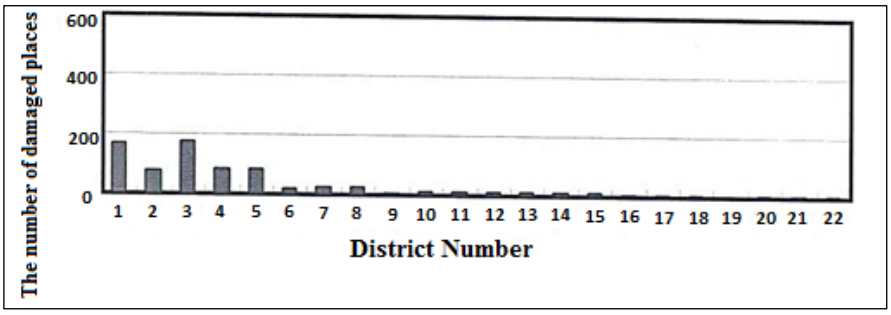

Diagram 3. The Vulnerability of water supply pipelines in different districts of Tehran based on the Fault model of the north of Tehran

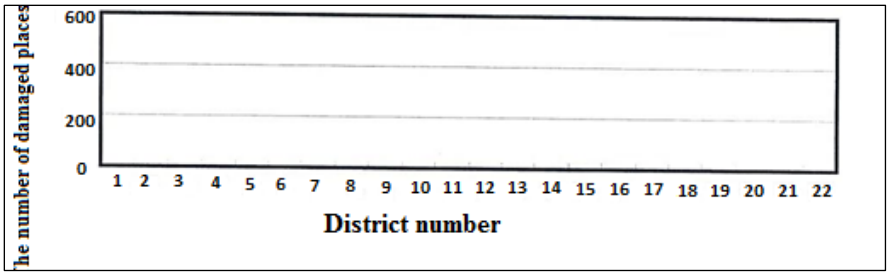

Diagram 4. The Vulnerability of water supply pipelines in different districts of Tehran based on the fault of Masha model

Materials and Methods

The tools and methodology used to conduct this research are represented in **Diagram 5.**

Validity and Reliability

To examine the reliability of the questionnaire used in this research, the Cronbach alpha coefficient was used. The mentioned questionnaire was distributed among the experts and officials of Tehran Water and Wastewater Company and experts of crisis management and emergency conditions of Tehran. Thirty three experts participated in this study. The collected data were analyzed using SPSS and the value of Cronbach's alpha was calculated.

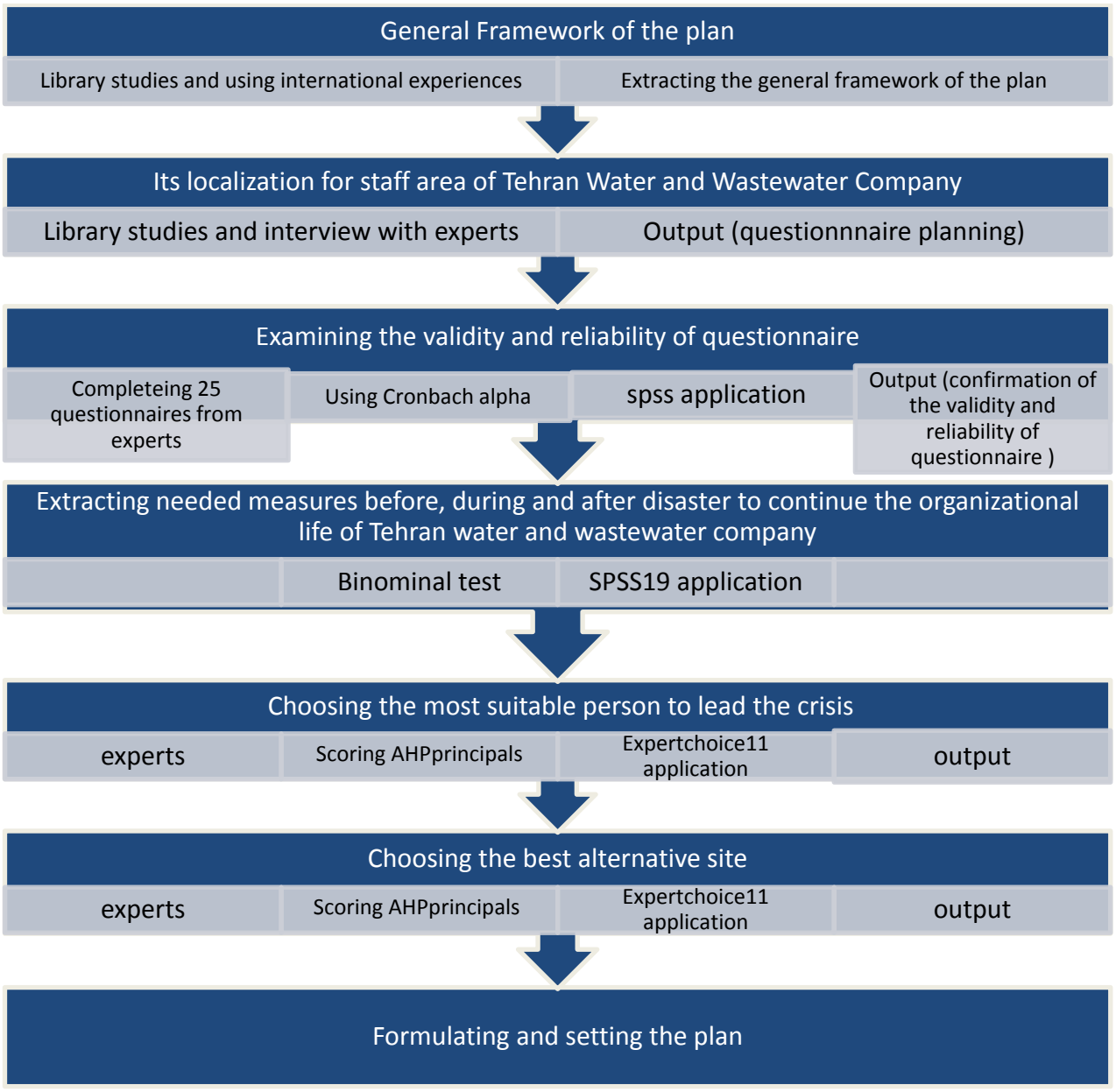

Diagram 5. Research Methods and Tools (Source: Authors)

Table 2. The value of Cronbach's alpha coefficient for assessing the reliability of the questionnaire (research results)

Item numbers	Cronbach's alpha coefficient based on standardized items	Cronbach's Alpha Coefficient
33	0.953	0.946

Table 2 indicates that the questionnaire has a high-reliability coefficient. Therefore, it can be concluded that the obtained results of this questionnaire has high validity and reliability.

Hierarchical Structure

Analytic Hierarchy Process (AHP) is a flexible model that relates individual judgments with values in a logical manner. The first step in this process is to make a hierarchical structure of the studied subject. The process steps that will be used in this research include calculation of the criteria weight (significance coefficient), calculation of the weight (significance coefficient) of the choices (various kinds of alternative sites and different

people for the responsibility of the plan leadership), and finally, examination of the logical compatibility of the judgments. Related indices to each section of the research are presented in **Diagrams 6 and 7**. Each of the above indices is defined based on the experts' opinions and library studies conducted in this context.

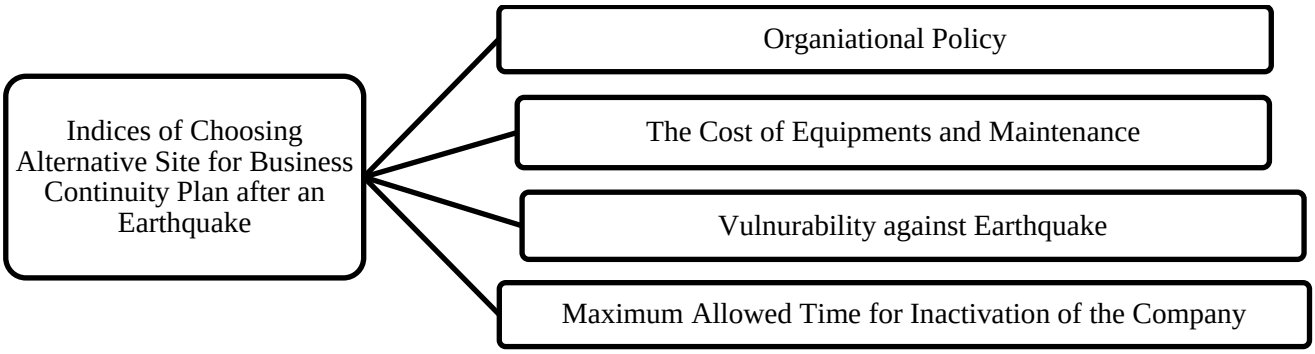

Diagram 6. Indices of choosing an alternative site for BCP (research results)

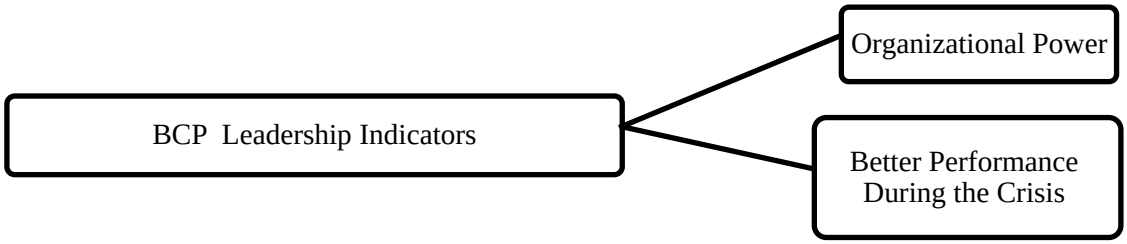

Diagram 7. Business Continuity Plan Leadership Indicators (Research results)

Test of Binomial Hypotheses

Hypotheses related to defining the measures before, during, and after crisis for business continuity of Water and Wastewater Company were measured by the binomial test. For this reason, a 5-option Likert scale was used including completely agree, agree, agre to some degree, disagree, and entirely disagree options, which were scored as 5, 4, 3, 2, and 1, respectively (16). To do the hypothesis test for the proportion of success (here dissatisfaction of the experts implies the average, low, and very low options), the measurement criterion was set as 0.6. The hypotheses of this test were defined as:

H0: P≥0.6 Satisfaction toward this choice is not high

H1: P <0.6 satisfaction toward this choice is high.

Test Results

Test results for the variables of before, during, and after crisis measures for business continuity of the Water and Wastewater Company, measured by the binomial test, are presented in **Table 3**:

Table 3. The test results for the variables of before, during, and after crisis measures

Row	Measure type	The number of tested variables	Result	The number of confirmed variables
1	Before a crisis	15 variables	Declaration of satisfaction for all the 15 variables	15
2	During and after a crisis	18 variables	Declaration of dissatisfaction for variable 6 and 18 and satisfaction for remained variables	16 variable

Discussion

This research was conducted to build up a BCP after the earthquake for Tehran Water and Wastewater Company. Therefore, research results and findings have been set in the BCP after the earthquake for staff area of Tehran Water and Wastewater Company.

Business continuity plan after the earthquake for staff area of tehran water and wastewater

The plan, formulated using the research results comprises of 10 main sections numbered from 1 to 10. Each section has sub-sections, in case of need, and is named with letters under the same section.

Objectives and scope of business continuity plan

This plan is defined in reaction to unexpected changes in the workplace of staff area in Tehran Water and Wastewater Company and explains the required steps that should be done in the case of earthquake occurrence and interruption in ordinary activities of the company. This document explains the needed measures in detail before, during, and after the crisis for business continuity of the company after the earthquake. It ensures the integrity of data and describes the essential actions to come back to the normal business processes.

This plan is designed in the scope of the staff area of Tehran Water and Wastewater Company and is applicable for earthquake disaster. It can be generalized to other disasters.

Authorities for implementation and activation of the plan

Table 4 demonstrates the contact information of the responsible individual, who is in charge of providing preparations of a BCP at the time of crisis occurrence. Besides, contact nformation of the alternative individual or individuals are presented in this Table. According to the library studies, the best individual for doing this is the head of crisis management section and the head of operations department, while the head of financial and official department can be introduced as the successors.

Table 4. The responsible authorities for continuity plan (research results)

Main person	Contact information	Alternative Individual(s)	Contact information
Mr/ Mrs	+989--------	Mr / Mrs... Mr / Mrs...	+989-------- +989--------

Necessary measures Before the Disaster

The list of measures needed to be continually done in BCP should be updated and reliable and are indicated in **Table 5** (these measures are gained through the library studies and questionnaire results).

Business Continuity Committee

In order to plan, execute, and follow-up the necessary measures to reach business continuity of the company after the disaster, it is necessary to create a committee called the BCP committee in the mentioned company. This committee is in charge of supervising, innovating, planning, approving, testing, and monitoring the plan. Implementation and execution of the plan, coordination of activities, confirmation of business studies that impact analysis, inspection ofBCP creation, and investigation of the results of quality assurance activities are the responsibilities of the committee. All representatives in various parts of the company, delegates of the subsidiary as well as the related companies may participate in the meetings of this committee. Duties of each section of the committee about the BCP after the earthquake are listed in **Table 6**.

Table 5. The needed measures for Business Continuity Before the Disaster and Responsible Authority (research results)

Row	Business Continuity Measures Before the Crisis
1	Creating a **BCP** committee for **BCP**
2	Holding regular meetings and following up the demands
3	Providing solutions to take advantage of international experiences in this field and to localize these experiences
4	Planning for the retrofitting of buildings, facilities and places for maintaining equipment and documents
5	Independent budget allocations for the **BCP** (such as retrofitting, purchasing new equipment in this field, backing up information and holding training courses and maneuvers ...)
6	Use and set up alert systems
7	Determining the duties of the individuals before, during and after the disaster, and the appointment of successors and keep them up to date
8	Full justification of the company's senior and mid-level managers about the topic through holding training courses and the installation of posters and banners.
9	Holding preparation maneuvers for staff preparation
10	Providing maps of critical sites, facilities, equipment, and access routes to them and keep it up to date
11	Backing up the company's essential documents, including financial documents, customer information, equipment and resource suppliers information, and ... and maintaining it in various and safe places.
12	Providing backup resources (such as emergency power and water resources)
13	Providing alternative communication means for communication in crisis situations
14	Reviewing the terms of insurance companies and concluding contracts with them to adjust the losses incurred to the company
15	Identify and provide alternative sites and equip them if necessary

Table 6. Different sections of the committee and their duties (research results)

Section	Duties
Management and leadership	-Creation of plan committee and holding regular meetings (at least once a month) -Allocation and approval of an independent annual budget -Define the individuals' duty description before, during and after the disaster and define the successors
Financial, official and information technology	-To predict and estimate the needed annual budget to implement the various measures of the continuation plan and submit it to the committee -Backing up relevant documents such as company's financial documents, customer's documents, contact list of the company and alternative forces -Studying the conditions of insurance companies and concluding the contracts with them
Coordination and support	-Coordinating and monitoring the analysis process of business impacts -Development of BCP and preparations of BCP -Creation of teams and workgroups and defining their responsibilities -Planning and execution of building, facilities, and sites retrofitting plan and maintaining the equipment and documents -Planning and setting up alert systems -Providing back up resources (emergency power and water) -Defining and preparing alternative sites
Education and Research	-Taking advantage of international experiences in this field and to localize these experiences -Holding preparation maneuvers for staff preparation -Providing maps of critical sites, facilities, equipment, and access routes to them and keep it up to date
Security and mobilization	-Studying to see if all sections of the plan supply the security requirements of the company -Preparation of alternative communication resources -Maintaining critical records in safe places away from the site -security cooperation in providing maps and access routes

Measures During and After the Disaster

Table 7 demonstrates the list of activities required to be done during and after the disaster to continue the company's activities. The results of this table are based on the results of the questionnaire analysis, which was designed for this purpose and distributed among the related experts.

Table 7. Measures for business continuity during and after the crisis (Research results)

Row	Measures for Business Continuity during and after a disaster
1	Immediate evacuation of staff after the alert (in the shortest possible time and with high safety and deployment in a safe place)
2	Coordinating with the relief forces for their quick presence at the company site and rescue of potential victims
3	Work beginning of the disaster leadership and management system
4	Examining the extent of damages and estimation of damages
5	Supervision and control of firefighting operations so that minimum damage threats the equipment and documents.
6	Contact with responsible people and, if necessary, a successor for attending and performing specified activities
7	Make necessary arrangements for business retrieval and planning for this purpose
8	Control and monitoring of facilities and equipment store, repairing and fixing them, if necessary
9	Supplying needed equipment and facilities for business continuity (rent or purchase of equipment, etc.)
10	Contact with relevant organizations (such as suppliers of equipment and resources, etc.)
11	Coordination with insurance companies to compensate the losses and carry out expertization affairs
12	Set up a backup power system
13	Providing alternative water sources
14	Setting up alternative communication systems
15	Make the necessary preparations to transfer to an alternative site and starting to work there
16	Control and monitoring the debris removing in buildings and facilities according to the previously defined plan and method so that minimum damage happens to the existing facilities and pieces of equipment.

Organizational Chart (after the disaster) with the Approach of Business Continuity

The first step for disaster management and the company's business continuity after a disaster is to have an accountable organizational chart to meet all needs of the company after a disaster and provide business retrieval conditions. In this part of the plan, a responsive organizational chart is explained. In order to define the crisis leadership with continuity approach, parameters such as the person's organizational power for leadership in the time of crisis, better performance, and more efficiency in the time of crisis were assessed by experts. In addition, scoring and rating were done using the AHP method. In the **Diagram 8**, the analysis results , gained by asking 10 experts in Expertchoice11application are indicated.

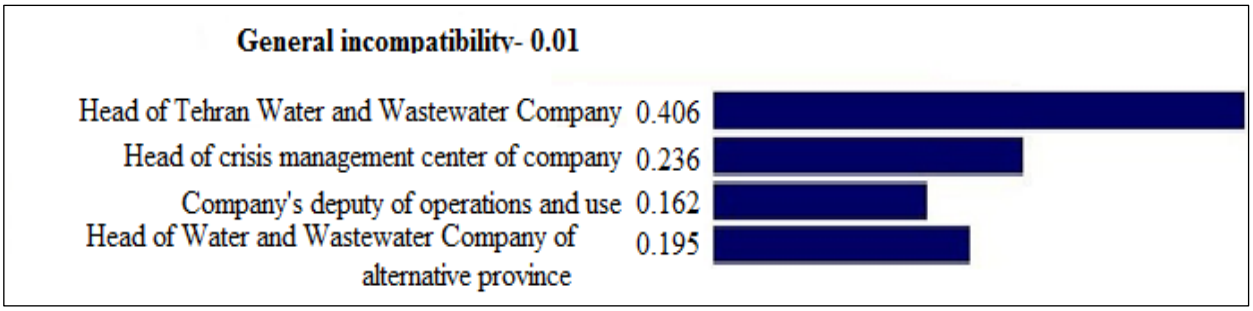

Diagram 8. Results attained from Expert choice application for selecting the crisis leadership (Source: Authors)

As Diagram 8 shows, the head of Tehran Water and Wastewater Company was chosen by the experts as the best individual for crisis management. According to the experts' opinions and library studies in this field, the following organizational chart was proposed **(Diagram 9)**.

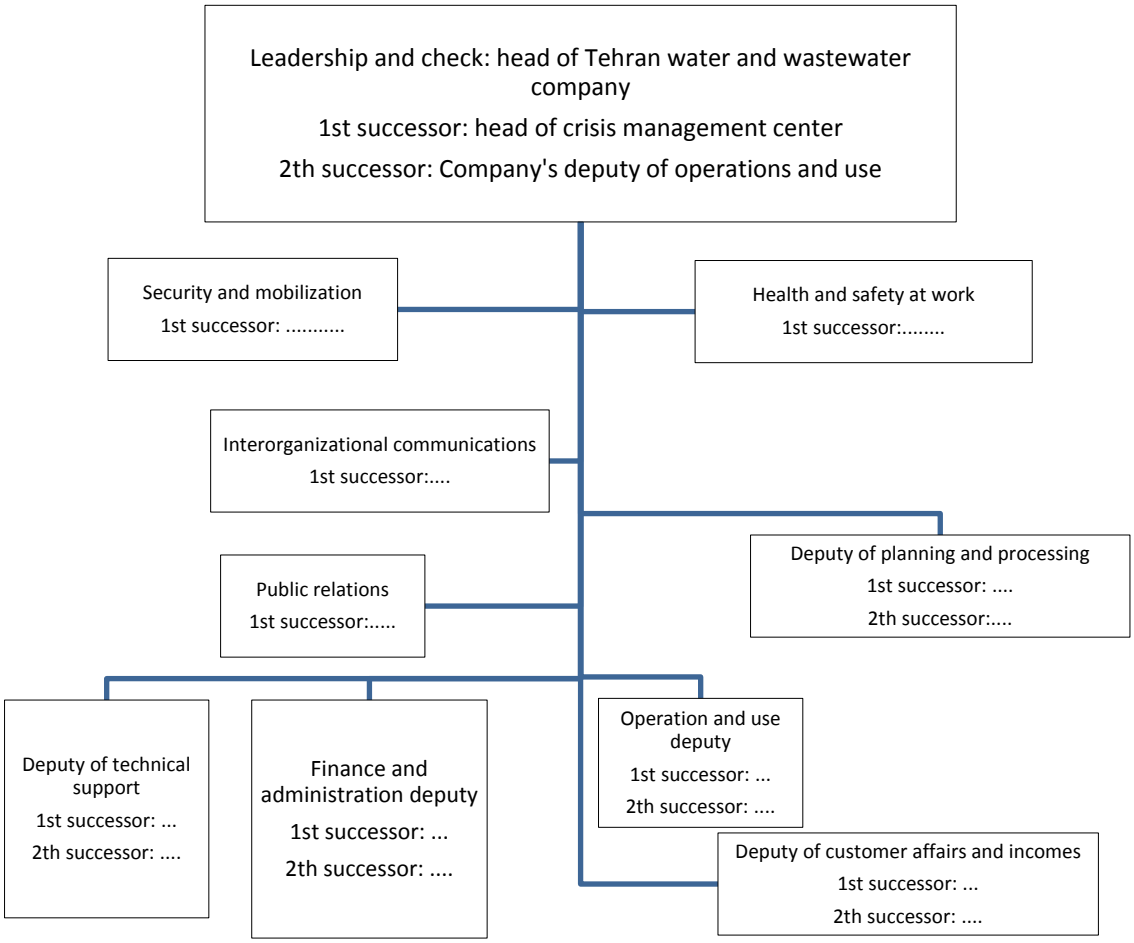

Diagram 9. Organizational chart of Tehran Water and Wastewater Company after the disaster (research results)

Appropriate and suitable reaction to a crisis in an organization require a team to lead and support reaction and retrieval operations. Team members should be selected from experienced and trained staffs who know about their duties. The number and scope of the team activities can include the followings:

Leadership and supervision teams, which contain a crisis management team and a reaction, continuity, or retrieval management team. Operational teams that can include the alternative site organizing team, the preparations and contracts team, the rescue and damage assessment team, the economic team, the hazardous material team, the insurance team, the legal affairs team, the alternative communications team, the mechanical equipment team, the intermediate or central processing team, alert team, local network or pcs team, public relations and media team, transportation coordination team, and important records, and documents management team. The duties and responsibilities of each team include distinguishing the individuals and team structure, perceiving the team's particular tasks, members' roles, and responsibilities, making contact list, and recognizing alternative members **(Table 8)**. A guideline is also required for teams to help other teams to do the duties and tasks of the team in the case of losing or unavailability of staff. This could be done by providing mutual pieces of training.

Table 8. Different parts of the disaster management leadership system and their tasks (research results)

Section	Duties
Leadership and supervision	*Leadership of the disaster and supervising on the excellent working *Organizing coordination meetings and planning the affairs
Planning and processing	* Assessing the amount of damage and estimating the incurred damages and economic losses to the company * Establishing company's retrieval committee and planning for business retrieval and, if necessary, rebuilding it
Coordination and technical support	* Organizing the alternative site and coordination in transportation * Repair of damaged equipment *Providing needed facilities and pieces of equipment by renting or purchasing from other companies in the shortest possible time *Setting up alternative power systems *Supplying alternative water sources
Administrative and financial	* Contacting the critical individuals of the company and if necessary, successors to be present at an alternative site and do the assigned tasks * Coordinating with insurance companies to receive the cost of incurred damage to the company * Related issues to preparations and contract parties and company's legal issues
Operations and use	* Doing the company's operational affairs * Estimation of usable mechanical pieces of equipment and managing them * Checking company's assigned tasks such as broken water pipes, repairing of tanks and water treatment plants, etc
Security and mobilization	* Establishing enough security in the company environment * Setting up and using alternative communication systems * Providing the security of company's operational forces in the city to do the operations
Health and Safety at Work (HSE)	* Quick alert and staff evacuation from hazardous places and guiding them to safe places by the help of mobilization and security forces * Creation and leadership of rescue teams * Control of dangerous materials such as Chlorine gas leakage, etc * Firefighting in places that essential documents of the company are placed
inter-organizational communication	* Communicate and coordinate with help forces to be present in the company and help injured people * Doing needed communications and coordination with related organizations and holding meetings with them if necessary
public relations	* Informing customers and shareholders * Informing mass media

Alternative sites

If the company's place, facilities, IT resources, networks, and main performances are lost, an alternative site should be available. Generally, three kinds of alternative sites exist:

Cold site: is an alternative site that is not ready for work. Before operations can be started there, appropriate pieces of equipment must be installed. Much more time and work are needed to prepare a cold site as a completely operational site. Cold sites are among the low-cost options.

Warm site: is thoroughly prepared and equipped electronically. It contains all pieces of equipment and can be operational within a few hours. Warm sites are more expensive than cold sites.

Hot site: is completely equipped, which frequently has staffs too. These sites can be

activated in almost a few minutes or seconds. These sites are the most expensive choices, but they can be operational in the shortest time.

In order to choose the alternative site to keep up the organizational life of the Tehran Water and Wastewater Company, parameters such as organization's policy, cost of preparation and maintenance, vulnerability against earthquake, and the maximum of allowed time for company's inactivation were assessed by experts and the considered options were scored comparatively by AHP directions. Then, these scores were analyzed. The achieved results are represented in the following diagrams.

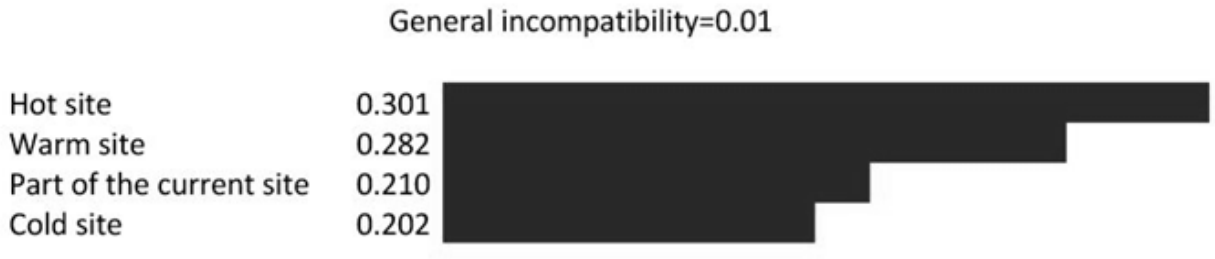

Diagram 10. Expert choice results for a selection of alternative site (research results)

As indicated in **Diagram 10**, according to the indicators mentioned above, experts allocated the highest score to the hot site, which is followed by the warm site.

Contact information of key responsible individuals

In **Table 9**, the contact information of all senior and middle managers and all the employees of the company and the contact information of the successors are presented, so that they can be accessed in the time of crisis.

Table 9. Contact information of the responsible people in the company (research results)

Person's name	Position	Contact information
Sir/ Madam	CEO	+989--------
Sir/ Madam	CEO Deputy	+989--------

Business Continuity Plan Maintenance Processes

Test and practice of the plan

Different sorts of maneuvers enable the organization's managers to distinguish the undefined and impossible cases and to give the best solution for making the plan understandable and applicable. Various service organizations such as gas, power, municipality, and other companies related to Tehran's Water and Wastewater Company should take part in joint maneuvers to ensure about coordination of these organizations for business continuity after a disaster like an earthquake. Furthermore, the strengths and weaknesses of this program will be recognized and corrected in such maneuvers. The BCP officers at Tehran Water and Wastewater Company are responsible to make decisions about the kind of practice, which includes multistage, simulation, or table control practice. These staffs are proposed to take periodical tests every 2 years. In this test, the officers of crisis management and BCP together with crisis management authorities of other related organizations, who are engaged with the business continuity after disaster attend in a round-the-table maneuver. Before the test, the attendants will be informed about the most recent status of the region and the maneuver will be started by providing a scenario of emergency and abnormal conditions in the company. By giving the scenario, all the attendants will decide about the reaction and operations that should be conducted. The spokesman will control the discussion meeting and its progress. In this phase, all requirements of the formulated BCP are executed. At the end of the maneuver, a written summary of the periodical test

will be provided. The outcomes of this stage will be applied to the review stage of the plan.

The practices should be carefully planned, they should be real and based on the idea of shareholders to minimize the risk interruption in the activities. In each activity, the general and detailed objectives must be clear. It is essential to prepare a report after each practice and analyze it by indicating how to achieve the objectives, which consider the suggestions and project timing. The scale and complexity of the practices should be compatible with the recovery objectives in the organizations. Business continuity plan and crisis management program must be checked and practiced to ensure about appropraite operation of its details and directions. In the practice program, the role of all people and staff should be checked, which contain the role of key individuals, third parties, and external partners to anticipate the recovery activities.

Reviewing and modifying the plan

Test and practice programs and preparation maneuvers should be precisely evaluated and assessed. Moreover, strengths and weaknesses of the plan should be measured. Later, the BCP sjuld be reviewed and modified for the given company.

Appendixes of the Plan

- Keeping Place of the Plan's Documents

In **Table 10**, the type of documents and their keeping place are presented so that individuals can have access to them in disasters.

- Timetable of the plan's update

In **Table 11**, dates of the continuity plan formulation and plan review and modifications are presented.

Table 10. Document type and its keeping place (research results)

Row	Type of Document	Keeping Place
1	Copy of financial documents of the company	An alternative site, code 101
2	Copy of costumers' information	An alternative site, code 102
3	Copy of shareholders and subsidiaries' information	An alternative site, code 102
4	Related documents to facilities and pieces of equipment information	An alternative site, code 102
5	Contact information of the company's staff and managers	An alternative site, code 103

Table 11. Plan's update history (research results)

Row	Modification Type	Date
1	Preparing the initial version of the plan	2012.06.20
2	Modifing parts of the plan after evaluating the conducted maneuver in date ---	----------

Conclusion

1- A set of measures were presented for the period before, during, and after an earthquake; then, the tasks descriptions of each part were determined according to the organizational structure defined for Tehran Water and Wastewater Company.

2- A set of post-earthquake necessary actions were determined for business continuity of the company.

3- A localized standard of the BS-25999 based on the organizational criteria of the Water and Wastewater Company led to a business continuity committee of pre-disaster as well as a response organizational chart during a disaster.

4- The head of Tehran Water and Wastewater Company would be the best person for managing the emergency management, maintaining the business continuity of the Company, and returnning to normal condition.

5- The hot site was selected as the best site for business continuity of Tehran Water and Wastewater Company, which could be an alternative site to continue the activities and services after the disaster.

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Conflict of interest

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Authors' contribution

All authors contributed to this project and article equally. All authors read and approved the final version of the manuscript.

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