Local Governments' Preparedness State for Chemical Related Disasters Prior to Great East Japan Earthquake and Tsunami on March 11, 2011.

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SUMMARY:
Disaster preparedness has high priority in Japanese government policies experiencing many types of natural disasters. Many safety regulations for disaster prevention are in place for residential areas. After Tokyo Sarin-gas attack in 1995, the government sectors prepared disaster prevention manuals for nuclear, biological and chemical (NBC) attacks and started annual drills. All Such preparations are based on assumption that the affected area is small and all the required resources are available to contain the NBC attack in time. Our survey, on government offices in 47 prefectures, regarding their preparedness for a large scale chemical disaster indicate that the government of Japan was not prepared for multiple outbreaks large scale chemical disaster. In local governments' point of view, the knowledge required for chemical disaster preventions are highly scattered putting the responsibility mainly on respected industries.

Keywords: Chemical Hazard, Chemical Disaster, Disaster Preparedness, Government response

1. INTRODUCTION

Japan is a key global player in the Industrial and Technology sector. High concentration of industrial zones needs special considerations in regards to the potential environmental hazards and risks. Huge quantities of hazardous chemicals are needed for industrial use. The production lines, storage facilities and distribution networks for hazardous materials are all in the risk of occurrence of natural disaster that may incur into a wide range of adverse secondary disasters such as industrial fires, explosions, and large spills or releases of chemicals into the environment. This could affect both businesses and the public considering that it is very common for industrial companies to operate in densely urban areas and often near public water supplies.

Even though the frequency of chemical disasters is low in Japan but their effects are very significant in the terms of loss of lives, injuries, environmental impacts and property damages. In case of Japan the frequent natural hazards, i.e. earthquakes, tsunamis, volcanoes, etc. increases the severity of chemical disasters specifically in densely populated areas.

Although isolated incidents can be dealt with by the small group of experts; the industrial accidents as secondary disasters will pose an additional risk after large scale natural disasters. An earthquake for example poses risks for industrial facilities or a tsunami poses risk for the industries in coastal areas and there may not be enough resources to contain the chemical spills since the infrastructures and life lines maybe hampered by the main event.

Hence, there is an urgent need to have an effective response mechanism to ensure that the impact of such emergencies is kept to a minimum. The recent experiences of unforeseen large scale events around the world such as the great East Japan Earthquake and Tsunami March 11, 2011, Haiti 2010, China 2009 and Indian Ocean 2004 (India and Indonesia) puts more emphasis on the necessity of a better preparation and planning for such extreme events in risk reduction methodologies or Disaster

recovery systems.

Fig. 1 shows the awareness of Japan government of a large magnitude 8+ Earthquake in the region however many of the assumptions were not sufficient and addition to vast destruction by tsunami many industries reported damage and fire. Fire reportedly broke out throughout the disaster region as aftermath of M9.0 March 11, 2011 Great East Japan Earthquake and Tsunami: At natural gas storage tanks at Cosmo oil refinery (633,000 barrels), Ichihara Petrochemical Complex (Output: ethylene 2,012,000 ton/year) and Electric Power (5.5 GWs/h) and shipbuilding companies in Ichihara City Chiba Prefecture (Ref.: 2006 Ichihara City Office website accessed April 2012).

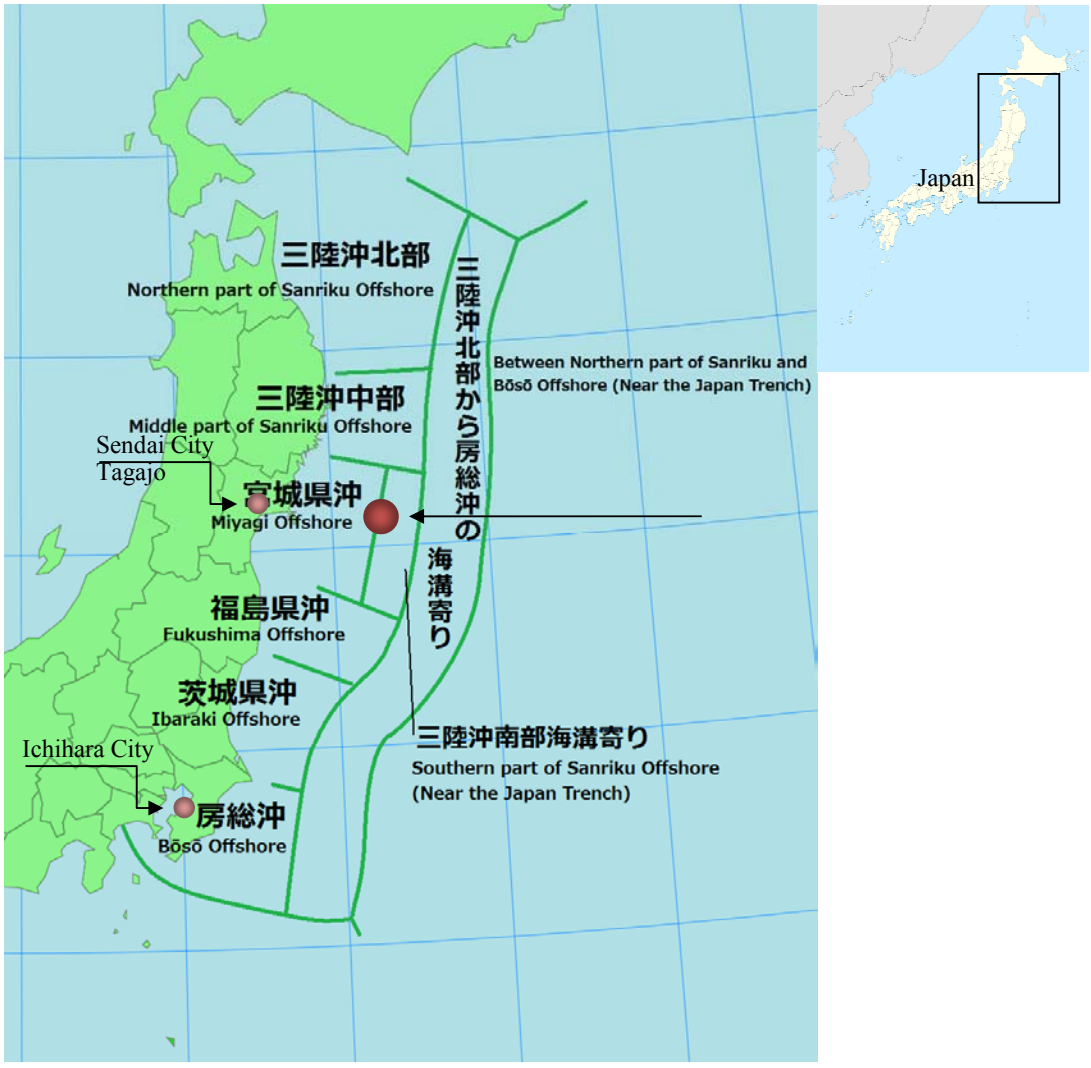

Figure 1. Map of East Japan subduction-zone Assumed to cause the Tohoku Earthquake Scenario prior to 2011 event. (The Japanese Headquarters for Earthquake Research Promotion, 2002)

Fire also reported from an oil refinery in Tagajo, Miyagi Prefecture (AP Photo/Koji Sasahara March 13, 2011) and flames engulf buildings and Facilities in an industrial complex in Sendai Port (AP Photo/Itsuo Inouye, March 12, 2011).

1.1. Background of the research

The first organization who included the Disaster Management into the regulations was the Britain's Board of trade (1840). However in Japan the latest scientific survey on chemical disaster preparedness

was conducted by Okumura et al. (2001). They studied 13 fire defense facilities and 52 core-medical centers nationwide. Their results show a high level of awareness amongst fire defense facilities but low level of preparedness due to budget shortages. On the core medical centers they found very low level of awareness toward a chemical disaster and therefore no signs of preparedness. Noda et al. (2006) compared the newly enacted soil decontamination law in Japan with Germany. In his article he quote "Compared with other countries, Japan's implementing of government regulations and providing fiscal support in this field have been too little and too late."

One of the innovative ideas in disaster management technology is called Collaborative Response Managements or Multi-Agency Disaster Recovery Systems. In fact it has been implemented traditionally in core structure of Japanese civil society since 1634, so called Edo period (Osaka Shikai Jimukyouku 1995, Takayori 1996, Okamoto 1997, Murayama 2003 and Haddad 2010). The examples of such are the local community-based fire-fighters (Shouboudan) and volunteer rescuers who have shown their effectiveness during January 17, 1995, Hanshin Earthquake in many stages of the disaster response. They acted effectively as first responders in the disaster area before the arrival of the Core Emergebcy Services (CES), helped the Non-combatant Evacuation Operation (NEO) and joined Disaster Relief Operations (DRO) as well as helping the Search and Rescue Operation (SRO) as local guides afterwards.

Having the background of Kobe, after the Indian Ocean Tsunami of 2004, many innovative ideas were put in practice, to involve the community in disaster response activities in regards with the residential areas (Enomoto 2007, Kawabata, 2008 and Miller 2011). It also increases the level of awareness and preparedness of the community as well as speeding up the NEO and SRO processes by reducing the travel distance and increasing the number of responders.

On the other hand, there are few articles about multi-agency response in disaster management systems of corporate ventures and Industrial sectors (Fotiou, 2009). Often the main concept of the recovery plan is to face the disaster alone. However with the current scale of disasters they generally lack the capability to cope with the complexity and uncertainty of the current events without a government intervention. Therefore a higher level of innovativeness (if exists) is required to mobilize the role of information, enterprise architecture, coordination and related human efforts aimed at improving the current state of preparedness and to establish an innovative multi-agency (private and public) disaster management system and discuss its issues. Although there is a common body of knowledge, disaster management is still an under-developed area of study. There is a need to relate practice and theory by using human-centered innovative approaches in a way that disaster management can realize its full potential.

Fukuda (2005) made a questionnaire survey about the amount of the safety information of a Chemical Plant that should be released to public. They concluded that the public is very anxious about the chemical plants since the accidents may spread outside. Therefore they desire a risk communication system to receive the information not about the chemical details but about the protective measures against accident and recommended actions in case of emergency. The main point of their survey was that the community needed the information first hand from the chemical plant directly.

After the March 11, 2011 M9.0 East Japan Great Earthquake and Tsunami the journalists Bird and Grossman, (Bird 2011), reported: "the city of Ishinomaki was a scene of devastation. The busy manufacturing and Industrial port town in Miyagi Prefecture, close to epicenter of the quake, had suffered the worst damage of any community in Tohoku region" they then added "Ruptured oil tanks leaked glossy black liquid, bags of agrochemicals sat in iridescent puddles, and the doors to a shed labeled "Chemical Storehouse" flapped open, revealing an emptied room." Then they emphasize the eminent danger to the responders and volunteer rescuers "Townspeople and officials walked through this huge field of wreckage, picking at the remains of their homes or simply gazing over the surreal landscape as if immobilized by the scale of damage.". They also listed about 130 major industrial centers along Japan's east coast were damaged or destroyed alarming the officials to assess another potential source of disaster related exposures: "Released of Hazardous Chemicals".

The major question we had was if the prefectural governments and municipal offices in the area have been aware of such possibilities. Therefore we started our interview and question survey to study the situation. Moreover we wanted to know if the governments are willing to engage in an interactive information sharing system during the disaster response as the public asked in Fukuda 2005 survey.

2. CHEMICAL MATERIALS AND SURVEY METHOD

The Ministry of the Environment (MOE) of Japan passed a law in 2001 for the chemical related businesses to estimate and register the annual amount, of the subject chemical substances that they released into the environment or transfer. The aggregate data has been published since the following year as so called Japanese PRTR (Pollutant Release and Transfer Register) (MOE, PRTR Website).

Chemical substances that are subject to the PRTR in Japan called Class I Designated Chemical Substances, which are selected based on their degree of hazard and the possibility of exposure (Please refer to MOE PRTR website for more detail). The so called Class I Designated Chemical Substances are a list of 354 hazardous substances that come under any of the following conditions of hazard and are persistent in the environment over a substantial area (MOE, PRTR website):

- Hazardous to human health and/or may adversely affect the ecosystem,
- Deplete the ozone layer.
- Easily form hazardous chemical substances through a naturally-occurring chemical transformation,

Each facility shall calculate and confirm the amount (Table 2.1) according to the following categories:

Released amounts	Transferred amounts
o Releases to air o Releases to public water bodies o Releases to the land (on-site) o Landfill disposal on site	o Transfers to sewage o Transfers to off-site

PRTR sets two thresholds for reporting business operators. The Facilities that should report are identified by their business types and company size. There are 23 types of businesses (listed in PRTR website) who should make Annual reports of their Release or Transfers. The size of the companies will be measured by their number of employees. The threshold is 21 or more regular employees.

The other threshold is based on capacity of facility, and the other is based on the size of business (i.e., the number of regular employees). The reports should consist of the Annual amount handled and/or the Annual amount handled, etc.: facilities with an annual amount of 1 ton or more (5 tons or more for the initial 2 years). But 0.5 tons or more for Specific Class 1 Designated Chemical Substances. Japan sets exceptional lower threshold for certain specific substances. The Japan's threshold for annual amount handled is set to 1t or more, which stands at relatively lower level compare to other countries (i.e., Canada and Australia). This setting widens the range of reporting business operators.

Furthermore Japan designates the specific substances such as carcinogens, and regulates them with more stringent rules among Class I. Within the 354 substances, 12 carcinogen substances are designated as “Specific Class I Designated Chemical Substance.” For these 12 substances, the threshold for reporting to PRTR is set to half of the required amount, 0.5t or more.

In this research we focus on substances in which their spill during an extreme natural event would

cause immediate health issues. We will focus on seven substances in "Specific Class I", which have Oral or Aspiration toxicities. Such substances if released will have short term and long term effects on rescue workers and volunteer groups who have no trainings and protective equipments to deal with such situations. Substances in which have Oral toxicity and Aspiration toxicity that are directly harmful to the first responders and volunteer rescue teams are very important for this research. We identified 7 of these substances in Class S substances and choose our target prefectures and Cities for interview based on that areas. We focus our research over the companies which are using or transferring these seven substances

In 2009 a total of 38,142 Registry were made for the "Class I" chemical materials to the Environment Ministry of Japan through the Pollutant, Release and Transport Registry (PRTR). Table 2.1 lists the number of reports by facilities in each prefecture and the number of reports for Class S substances with oral and aspiration toxicity (7 substances). The table shows Aichi prefecture has the maximum number of facilities with 2,258 and 52% of that registers are for the "7 Substances" followed by Hokkaido (1,946) and Osaka (1816). The lowest number of facilities is in Kochi with 204 and Okinawa is the next with 222 registers

Table 2.2 is showing the distribution of the facility registries based on release, Transfer and type of transfer in Japan for All Japan as well as for 7 Class S substances of our interest for Oral and Aspiration toxicities. Table 2.3 is showing the amount of the substances released or transferred in annual year 2009.

Table 2.1. List of PRTR Chemical substance register in year 2009 in different prefectures of Japan.

Prefecture Name	Registry All Class I	Registry Oral and Aspiration Class S	Prefecture Name	Registry All Class I	Registry Oral and Aspiration Class S
Aichi	2258	1183 (%52)	Yamaguchi	586	359 (%61)
Hokkaido	1946	1135 (%58)	Yamagata	582	340 (%58)
Osaka	1816	779 (%43)	Toyama	556	284 (%51)
Hyogo	1693	785 (%46)	Iwate	531	262 (%49)
Saitama	1620	701 (%43)	Ishikawa	499	269 (%54)
Kanagawa	1583	810 (%51)	Akita	497	313 (%63)
Shizuoka	1519	782 (%51)	Ehime	497	284 (%57)
Tokyo	1382	778 (%56)	Kagoshima	483	325 (%67)
Chiba	1379	683 (%50)	Aomori	469	276 (%59)
Fukuoka	1312	794 (%61)	Kagawa	434	254 (%59)
Nagano	1285	687 (%53)	Oita	410	246 (%60)
Ibaraki	1131	470 (%42)	Fukui	410	170 (%41)
Fukushima	1043	505 (%48)	Miyazaki	351	203 (%58)
Niigata	1020	577 (%57)	Yamanashi	348	175 (%50)
Hiroshima	961	566 (%59)	Nagasaki	335	204 (%61)
Gifu	947	382 (%40)	Wakayama	330	155 (%47)
Okayama	895	447 (%50)	Nara	330	141 (%43)
Mie	841	388 (%46)	Saga	322	196 (%61)
Miyagi	815	451 (%55)	Tokushima	315	179 (%57)
Gumma	802	381 (%48)	Shimane	290	139 (%48)
Tochigi	727	308 (%42)	Tottori	284	178 (%63)
Kyoto	642	281 (%44)	Okinawa	222	151 (%68)
Shiga	641	235 (%37)	Kochi	204	128 (%63)
Kumamoto	591	353 (%60)			

Table 2.2. PRTR 2009 Annual report Facilities Outline Using Special Class I and 7 Class S substances

Chemicals Name / Facilities	All 354 Class I Substances	Seven of Class S With Carcinogenicity and Oral Toxicity						
		60 - cadmium and its compounds	69 - chromium(‡Y) compounds	77 - chloroethylene; vinyl chloride	179 - dioxins	252 - arsenic and its inorganic compounds	294 - beryllium and its compounds	299 – benzene
Releases Reported	125142	623	882	32	3835	918	1	17035
Transfers Reported	29801	47	353	5	2060	64	2	68
Total Reported	217196	3168	3650	35	4176	3171	6	19809
Air Emission	98714	43	38	32	2855	30	0	16520
Water Bodies	28235	604	845	10	1457	908	1	540
Land	70	0	0	0	4	0	0	1
Landfills	290	8	0	0	199	10	0	0
Total	127309	655	883	42	4515	948	1	17061
Waste	29008	47	328	3	2032	62	2	65
POTWs	2777	1	42	2	161	8	0	5
Sub Total	31785	48	370	5	2193	70	2	70

2.1. Survey questions

We distributed our question survey to all 47 prefectures of Japan and the return rate were %13. One of the reasons for low turn-up may be the timing of the survey. The prefectural governments were too busy preparing for next fiscal budget during February and March therefore we may receive their replies after submission of this article.

In addition to the prefectural governments we distributed our question survey to 30 cities with more than 15 chemical registers for selected chemicals in 2009 PRTR as well as 8 cities that suffered from the tsunami attack. From the total 38 city municipal offices 8 replied to our questions (%21 turn-out).

We traveled to the disaster region and interviewed the city municipalities in Fukushima and Soma cities in Fukushima prefecture, Sendai city in Miyagi prefecture and Morioka city in Iwate prefectures which helped us to understand the reasons behind the answers to our questions and increases the number of data collected.

The questions of the survey were same for the prefectures and for the cities. The questions are designed based on three objectives. First question was a general question in relation to the activities toward the recovery of the disaster area:

Q1. How did you contribute in the March 11 Great East Japan Earthquake? Fire Fighters and equipment, DMAT dispatch, Relief goods, etc.

The second question was about the awareness of the government on Chemical disaster issues:

Q2. Is Chemical disaster preparedness important to your department?

Question 3 asking about the preparedness of the government, if there is a section or department which is dealing with the chemical related emergencies and accidents or if there are any manual

Q3. How many employees are in charge of handling chemical accident in your Department?
Q4. Do you have any chemical disaster manual (documented steps to be taken when a chemical disaster occurs, covering life safety, crisis communications and decontamination)?

Table 2.3. PRTR 2009 Annual report for Release Outline Special Class I

Chemicals Name / Facilities	All 354 Class I Substances (t/year)	Seven of Class S With Carcinogenicity and Oral Toxicity						
		60 - cadmium and its compounds (t/year)	69 - chromium(‡Y) compounds (t/year)	77 - chloroethylene; vinyl chloride (t/year)	179 – dioxins (mg-TEQ/year)	252 - arsenic and its inorganic compounds (t/year)	294 - beryllium and its compounds (t/year)	299 – benzene (t/year)
Releases-Air Emission	155796	1.8	16	245	103	4.5	0	806
Releases Water Bodies	8506	1.9	9.1	6.5	1.5	19	0.001	4.6
Releases Land	462	0	0	0	4	0	0	0.005
Releases Landfills	11125	86	0	0	249	1001	0	0
Releases Total	175890	89	9.3	252	354	1024	0.001	811
Transfers Waste	171774	88	333	69	2865	256	0.022	869
Transfers POTWs	1407	0	1.7	1.8	0.07	0.01	0	3.3
Transfers Total	173181	88	335	71	2865	256	0.022	872
Total Releases and Transfers	349071	176	344	323	3219	1280	0.023	1682

Questions 4, 5 and 6 are to examine the level of preparedness before and after of the March 11 earthquake and tsunami event:

Q5. Do you have any personnel training for chemical disaster response?
Q6. Do you have any regular drills for chemical disaster response?
    a. If yes, when was the last drill?
Q7. Did you have these trainings and drills before March 11 Great East Japan Earthquake?
    a. If yes, were the drills useful?

Questions 8 and 9 are to ask for the level of readiness and if there are any communication planed ahead of the extreme event:

Q8. What is your chemical disaster response system information-sharing and coordination policy? How do you communicate with Industry representatives?
Q9. Do you have a Chemical accident/disaster response section?
    a. If yes, how many personnel are working in this section? And

b. Do you have any personal protective equipment (PPE)?
c. Do you have any stock for decontamination reagent and equipment which are needed to be available for use following a disaster?

Question 10 addressing the needs of the local governments to handle the emergency situations:

Q10. Are there any help from centeral government to local governments after a chemical disaster?
   a. If yes, which type of helps do you need? Financial, Personnel, Technical assistance, Managerial assistance etc.

The question 11 and were asked to see if the governments would have the authorities to inspect the situations inside the factories.

Q11. Do have the authority to check the company's hazard and risk assessment reports?
   a. If yes, has the hazard and risk assessment reports been collected after March 11 Great East Japan Earthquake?

And the last question is a general informative question

Q12. Did you have any chemical incident report after March 11, Great East Japan Earthquake?
   a. If yes; Please indicate the type of incident

3. RESULTS AND DISCUSSION

Almost all the collected answers to question 1 was about the quantity and quality of the liquidity and goods mostly: Relief money, money donation, dispatch of the helicopter and person, the goods aid, temporary settlement of refugees. All government sectors said they sent the Disaster Medical Assistant Teams with firefighters to the area.

100% of the local governments wrote they think the Chemical Disaster Preparedness is necessary. However some suggests that the number of chemical substances is too many to have a universal approach for the detection and decontaminations. During the interview we suggested that special teams needs to be assigned to each factory and those team get required training by industries for a short period of time to be effective in disaster response.

Local governments do not have an organizational position for chemical disaster responder. But they engage in drills with firefighters self defense forces and DMAT. Subsequentlt there is no manual specific for large scale chemical incidents.

There are no exclusive training and drills designed for chemical disasters. However they have regular annual drills for search and rescue of the citizens.

There was nothing prior to the event and except the annual civilian drill in which no chemical scenario is not included.

Such system is not established yet or even thought between private and public sectors. And during the disaster there are no dispatch teams from office except the firefighters department.

All the offices did not have professional protective gears for such incidents nor the other required material for decontamination.

There are 70 percent who are generally agree with aid but only 22% were agreed by Managerial help. Others were speaking of the regulations with Aid packages. Fig. 1. Show the percentage of the suggested aids.

Only one prefecture said that they have the authority of disaster prevention assessment for the petrochemical complex. Another respondent said that they do not have any authority of force the companies, but there is the framework of corporation with municipal government and companies are following. They suggest some departments other than disaster management may have the authority for inspections based on the pollutant law. Other responders did not mention any such authority.

Despite the reports of fire and smokes from industrial sectors and oil tanks fire there were no chemical related incident reports based on our question survey

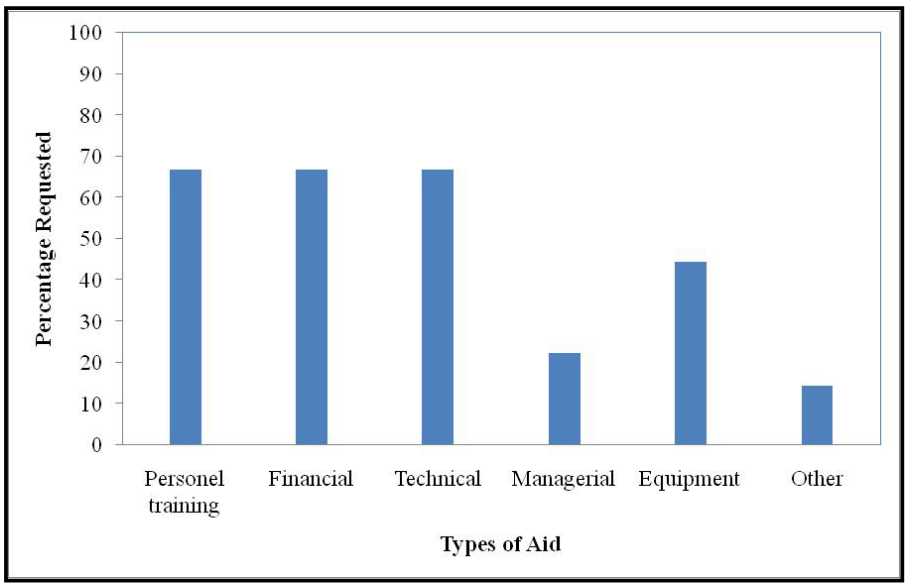

Figure 1. Requested Aid from the central government

The total analysis of the replies suggest that the disaster sections of the local governments are not inclined to cooperate with private sectors. On the other hand there are no preparations other than those for terrorist attacks. That as well is done by Self Defence Force (SDF), Police, Fire-fighters and Disaster Medical Assistant Team (DMAT), which could not be count as government preparation for an extreme event.

During the interview and survey almost all claimed that the number of chemical substances is too many to have a universal approach for the detection and decontaminations. We suggested that special teams needs to be assigned to each factory and those team get required training by industries for a short period of time to be effective in disaster response.

In general until the change in the government policies, the private sectors need to seek a different way to cope with the current situation in order to prevent any possible chemical problems may occur in future. After March 11, 2011 East Japan Earthquake, it was fortunate that no mass contamination happened in chemical industries and it was only minor fire break outs since the government is not ready to respond properly.

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