Modelling and Managing the Social Implementation Process for Rainwater Harvesting Technology Dissemination – Case Studies from Bangladesh and Japan

A thesis submitted in partial fulfillment of the requirement for the degree of Doctor of Engineering

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Contents

Chapter – 1: Introduction

1.1 Introduction

As we entered into the 21st century, new knowledge and innovative ideas have been produced and developed to prevent or mitigate the losses due to all kinds of disasters. The challenges of integrated disaster risk management are to successfully put the knowledge and innovative ideas into real practice or action (Gopalakrishnan, and Okada, 2004; Misra and Okada, 2005). Therefore, the goal of disaster risk management is to encourage the adoption of disaster reduction and mitigation measures (Paton, 2007) to enhance community's coping capacity. Coping is defined as a manner in which people contest, struggle, combat within existing resources and range of expectations of a situation to achieve various ends (Wisner, 2001). Coping skills and capacities can be physical, social, economic and institutional. Particularly, in a disaster they become collective instruments for organizing action on behalf of the disaster victims (Cuny, 1983). Examples of effective coping mechanisms could be found at the individual, the family, the extended family levels and also at large group level, like clan level, organization and region level (Cuny, 1983). This sort of local capacity and knowledge, unique to a given culture and exists within and developed around specific conditions, is created and enriched over time and is based on awareness, concern, willingness to do something and then actual work of people. (Warren, 1995). It may seem necessary to know the related values and perceptions, how it evolves and gets institutionalized in a community. In community based innovation dissemination process, while adopting a new idea, an individual observes the behavior of the members of his/her own community. Sharing information by the members of a social system in such a way creates a chain of social network that helps the members of the system to take a collective decision about the new idea (Granovetter, 1987, Valente, 1996). Therefore, it is instrumental to understand the social network development process in the dissemination of innovative disaster preventive technology.

1.2 Research Problem

The aim of this research is to systematically model and analyze the rainwater harvesting technology dissemination process in order to develop an adaptive management plan for the areas under water related risks; the major focus is placed on the role of social network development process.

This thesis addresses three different but mutually complementary scopes –
1) A microscopic perspective of social network development process among the anonymous individuals in the technology dissemination process.
2) The role of the different stakeholders and their network formation in the innovation dissemination process
3) Adaptive management plan for the social implementation of rainwater harvesting technology

As the first focus issue, based on the above mentioned scopes, this research attempts to address the following questions –

- (I) How the social network development among the users or adopters of rainwater harvesting technology contributed to the dissemination of the technology.
- (II)How the pattern of the networks have changed in the due course of dissemination.

Two different regions in which social innovation challenges have been under way to disseminate rainwater harvesting technologies. In the first case, the arsenic affected coastal areas of Bangladesh are selected where the communities are under risks due to lack of available drinking water source. In second case, the Sumida ward of Tokyo city is selected where the potable water is available to the community, but a disaster management plan to make use of rainwater harvesting is required in order to avoid future water related risks.

As the second focus issue this study addresses the following question –

- (I) How the social network development among different stakeholders in a technology dissemination process can be formulated and analyzed.
- (II) How to bring the innovative rainwater harvesting technology from the inventors to the end users

The third focus issue addresses –

- (I) what are the bottlenecks of rainwater technology dissemination and to what extent the concept of adaptive management can be actually conceptualized and designed for the social implementation of the technology.

1.3 Research Methodology

The present thesis is primarily based on social network approach in order to systematically analyze and manage the rainwater harvesting technology dissemination process in Bangladesh and Japan. Since in the dissemination of innovation all the individuals do not adopt at the same time, rather a group of individuals first adopt the tank, and then learning from them another group of individuals become motivated to adopt (Granovetter, 1982; Valente, 1996). An adopter's degree of innovativeness may vary in level and scale. The Social Network Threshold Model of The Diffusion of Innovation is employed to specify the adopter's degree of innovativeness in respect of system or region level and personal or neighborhood network level to understand the effects of macro and micro level networks on rainwater tank adopters in Coastal Bangladesh. Adopter categorization is created to determine the difference among adopters with respect to external influences, communication behavior and opinion leadership. Apart from the above mentioned model, various social network tools, like centrality, density, cohesiveness, structural equivalence model are deployed in order to explore further the nature and pattern of information sharing activities at different level. Such tools help to explore the degree, strength and direction of information sharing activities at micro and macro level. The Model has been examined by taking cases studies in the coastal areas of Bangladesh. Field surveys have been conducted to collect the relevant data to examine the model.

Another approach of the thesis is the "Network of organization" model which is communication development process among the stakeholders. This model helps to identify the stakeholders and their roles in the innovative technology dissemination process. It helps to examine how various players, acting as decision maker, interact and collaborate in the innovative technology dissemination process and eventually brings the invention from the inventors to the end users. This model has been tested in the rainwater harvesting movement of Sumida city. The data have been collected from the primary and secondary sources to test the model.

Apart from these two broad models, the present study explores the possible mechanism and strategies to disseminate and implement the innovation among the individuals who

have not adopted yet. For this, individuals' knowledge, perception about the tank and their priorities has been analyzed by developing questionnaires for the non-adopters of the tank. The surveys were conducted among the non-adopters of the tank both in Bangladesh and Sumida, Japan. Various statistical tools have been used to systemically arrange the results.

1.4 Structure of Thesis

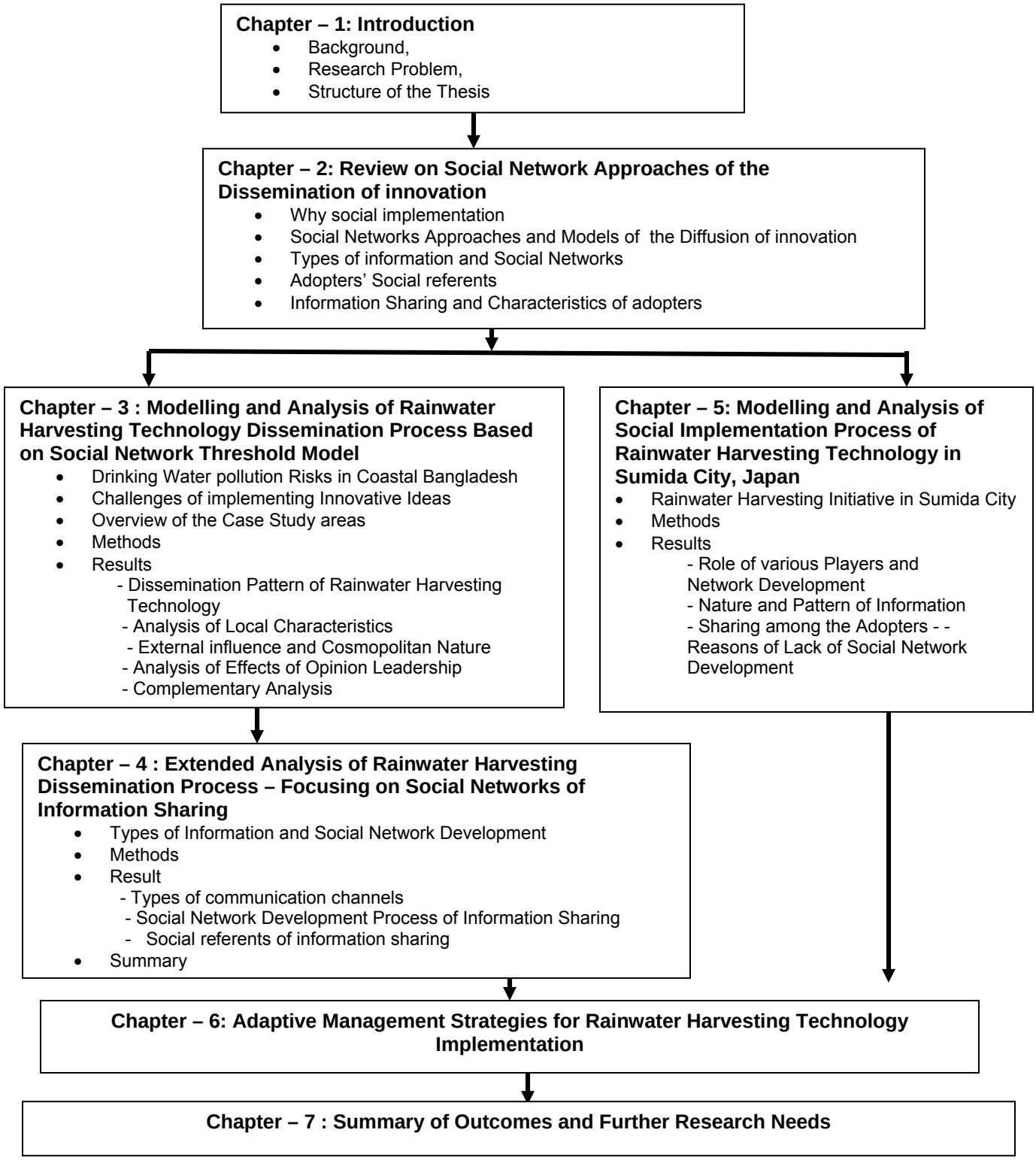

Fig. 1.1 Framework of the Study

Based on the above discussion, the structure of the thesis is designed as follows –

Chapter 1 introduces the background, research problem, methods employed to solve the research problem and the structure of the thesis.

Chapter 2 is devoted to literature review on the importance of social implementation of technology, particularly in integrated disaster risk management context. Special Focus has been given on the concepts of social network approach in relation to the dissemination of innovation. The studies examined role, pattern, nature of social networks in technology dissemination have been briefly introduced and discussed in this chapter.

Chapter 3 describes the magnitude of drinking water pollution risks due to arsenic contamination of ground water and water salinity in the coastal areas of Bangladesh. This chapter shows that in order to reduce those risks how an innovative mitigation measures, i.e., rainwater tanks have been disseminated in the rural and urban areas of Bangladesh. The focus has been deployed on the nature and pattern of dissemination process. Using Social Network threshold model, this chapter shows how the development of social networks at personal and community level helps the individuals to adopt the tank. Above all, individual characteristics, their satisfaction level, external influences are examined and analyzed in order to comprehend the impact of those components on the tank dissemination process.

Chapter 4 concentrated on information sharing activities in the various phases of tank dissemination process in Coastal Bangladesh. The direction, pattern, density of Three types of information sharing activities – hearing, observation, discussion have been examined to know that role of each information on adopter's decision making process. Structural equivalence model and cohesive model of network have been used to explore adopters' sources of different information.

Chapters 5 deals with rainwater harvesting movement in the Sumida Ward, Tokyo. In the first section of this chapter, the network formation among various key players of rainwater harvesting movement has been described. Based on Social network model developed by Okada (1993), it was attempted to shows how the collaboration and interaction among the players helps to bring the innovative rainwater harvesting technology to the end users. It also shows why and how network among the players are important in order to diffuse the innovation from one region to another. The later section of the chapters focused on the nature and pattern of information sharing activities among the adopters or tank users. It shows the bottlenecks of the implementation of the rainwater harvesting technology at a wider scale in order to meet the micro level requirements of the adopters in Sumida Ward, Tokyo.

Chapter 6 broadly deals with issues that need to be taken into consideration in order to develop an adaptive management plan for the rainwater harvesting practice. Priorities, affordability, choice and option of the individuals who have not adopted the tank are analyzed. First section of the study focused on Bangladesh and in the second section focus has been deployed on Japanese case.

Chapter 7 summarizes the main contributions of the research and refers to the needs for further extensions of this research

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Chapter – 2 Reviews on Social Network Approaches to the Dissemination of Innovation

2.1 Introduction

This literature review aims at examining thoughts and concepts of social network approach of the innovative technology dissemination process. At first, this chapter attempts to address why social implementation of innovative technology is important. The next section discusses the importance of social networks to promote innovative technology dissemination. In this section a focus is placed on a microscopic level in order to examine how the nature and pattern of social networks among the individuals or adopters influence the information sharing activities which eventually controls the innovation dissemination process. The last section introduces an approach dealing with the organizational structure and network development among the key players of an organization. Here a focus is shifted to a more macroscopic or organizational level of network development in order to understand the process of innovation dissemination.

2.2 Why social Implementation

An innovation is commonly defined as an idea, practices, or objects that are perceived as new by an individual or other unit of adoption (Rogers, 1983). Due to the newness aspect of an innovation, the adoption decision of an innovation to an individual is subject to uncertainty. Adoption of innovative ideas prescribes and demands a modification of the existing way of life of the local community. The successful implementation of innovative idea into practice is interpreted to occur under the two interrelated provision of – first, the community's perception, including believes and values etc, with reference to the new knowledge or innovative ideas and practices (Marris et al., 1998; Rippl 2002) and second, their capabilities or capacities to exercising such practices and to make the practice becomes sustainable (Lindell, and Whitney, 2000; Bravo et. al., 1990). The behavioral changes and the required capacity for the adoption of disaster measures may be managed through social interactions or social networks which exist in a community. Social networks enhance two distinctive processes that affect the adoption behavior: social learning and social influence (Rogers, 1983, Valente, 1995; Coleman et. al., 1957). Since the decisions of adoption of innovative ideas are subject to uncertainty (Rogers, 1983), learning from other's experience, exchanging knowledge and information, through social interaction reduce this uncertainty and thus may change the probability of adoption decision of individuals(Becker, 1970; Granovetter, 1983; Valente, 1995). An individual's social networks extend from his or her personal social domains consists of neighbors, friends, co-workers etc. to the greater social spectrum, i.e., system level including organization, clan, city, state etc. An individual may learn and be influenced from both personal and system networks, and may be both of these networks have distinctive impacts on an individual's adoption decision making process. Therefore, it is instrumental to understand the social network development process in the dissemination of innovative disaster preventive technology.

2.3 Role of Social Networks in the Dissemination of Innovation

An innovation is commonly defined as an idea, practices, or objects that are perceived as new by an individual or other unit of adoption (Rogers, 1983). As explained in the above discussions, due to the newness aspect of an innovation, the adoption decision of an innovation to an individual is subject to uncertainty. In a diffusion process, all the individuals do not necessarily adopt the innovation at the same time; rather it is adopted

by a person or group of individuals in the beginning and later on, other members of the community follow them (Granovetter, 1983). Thus, an individual, while adopting the new idea, observes the behavior of the members of his/her own community, which helps him/her to reduce uncertainty accompanied with the newness aspect of an innovation. Sharing information by the members of a social system in such a way creates a chain of social network that helps the members of the system to take a collective decision about the new idea (Valente, 1995). A social network is the pattern of friendship, advice, communication or support which exists among the members of a social system (Wellman, 1973). Becker (1970) mentioned that in the diffusion of, social networks help an individual in three ways – 1) to provide information about the innovation which otherwise an individual might have missed, 2) to provide social support of an individual's adoption decision and thus to legitimize the innovation, 3) to create social influence on an individual to accept or reject the innovation. So the role of social networks in the diffusion of innovation process is important because networks not only provide opportunities for the exchange of information and knowledge (social learning); they also impose constrains on behavior for those who might otherwise wish to innovate (social influence).

2.4 Social Networks Threshold Model of Diffusion of Innovation

Therefore, an individual's adoption behavior is a function of the behaviors of others in a group. This approach of diffusion of innovation, the threshold model of collective behavior, is postulated by Granovetter (1983). The Threshold model of collective behavior postulates that while adopting a new idea, an individual observes the behavior of the members of his/her own community to reduce uncertainty, therefore, an individual's adoption behavior is a function of the behaviors of others in a group (Granovetter, 1983). A threshold is the proportion of adopters in the social system needed for an individual to adopt an innovation. Individuals having a low threshold are recognized as very innovative who have adopted the innovative idea or technology when none or very few of its network members adopted. Similarly, high threshold individuals are those who adopted the innovation when a majority of his network members already adopted the innovation. Valente (1996) argued that the problem of this collective behavior threshold is that the individual may not be able to accurately observe the behavior of others in a social system and thus the individual relies much on his/her personal network for making

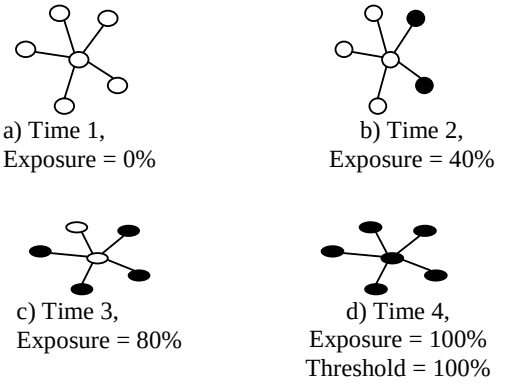


Fig. 1 Showing exposure and threshold in personal network (Source: Valente, 1996)

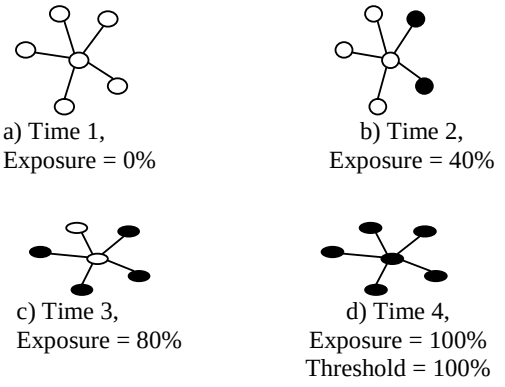


Fig. 1 Showing exposure and threshold in personal network (Source: Valente, 1996)

adoption decision. As a result, the adoption threshold must be measured in terms of direct communication links with others in contrast to collective behavior threshold (Valente, 1996).A personal network is the set of direct ties that an individual has within a social system (Wellman, 1973). In the course of diffusion of innovation, more and more people adopt the innovation and as a result the proportion of adopters in an individual's personal network generally increases. But this process depends on the structure of the system. Fig. 1 shows such a process of adoption in an individual's personal network. Exposure is the proportion of adopters in an individual's personal network at a given time. Since adoption threshold is the proportion of adopters in an individual's personal network, threshold is the exposure at the time-of adoption. An individual is thus very innovative if none of his/her personal network members adopted the innovation at the time of his/her adoption, that is to say, he/she is a very radical person as well as a low threshold individual. On the contrary, an individual is considered as very conservative if all the members of his/her personal network adopted the innovation before he/she adopted (Fig.1-b).

2.5 Technology Dissemination and Types of Information

In the technology dissemination process, the advantages and disadvantages of the technology are not well known to the potential adopters and therefore they face uncertainty while making adoption decision (Rogers, 1983). To reduce uncertainty about the innovation, a comprehensive knowledge or information is required for potential adopters. Now the question is what kinds of information are required or what types of information may make potential adopters to be certain about the innovation? Since an innovation is a technology, it consists of hardware and software components (Rogers, 1983). The hardware components include shape, size, structure and other engineering aspects, and software components are comprised by function, utility, effectiveness, operation system of the technology etc. Comprehensive knowledge of both software and hardware components of the technology help individuals to make decision. An individual becomes exposed or informed to an innovation broadly through two ways – hearing from others and observing the innovation. Hearing and observation are two distinctive information seeking activity. Hearing, a two-way communication process, offers an individual to learn about the software components of innovation including function, utility, effectiveness, investment cost etc. of an innovation. On the other hand, Observation is one-way communication process and it offers an individual to learn about the hardware components including shape, size, structure etc. Therefore, an individual' degree of knowledge or information about an innovation depend on what way he/ she exposed to innovation. For example, an individual, who heard about an innovation and also observed it, has better information and may take the adoption decision under lesser uncertainty than the individual who only heard about the innovation or only observed the innovation. However, technology adoption behavior is not an instantaneous activity, but it is regarded as a phased process which consists of – knowledge stage, persuasion stage, decision stage and implementation (Rogers, 1983). Knowledge stage starts when an individual becomes exposed or informed about an innovation (Rogers, 1983). But only knowledge about an innovation does not lead an individual towards adoption. After knowledge phase, in the persuasion stage and decision stage, individual also may seek advice and suggestion from other sources to make a prudent decision. Discussing with others and getting suggestion from various sources also influence an individual's adoption behavior. Therefore examining three information sharing activities – hearing, observation and discussion are instrument to understand the process of innovative technology dissemination.

2.6 Quantity of Information

The degree to which extent information is received by potential adopters may influence his/her adoption decision (Valente, 1995, Coleman et al, 1957; Rogers, 1983; Burt, 1983). For example, the individuals who might have received information from various sources at a large extent may be able comprehend the innovation more accurately and therefore may be able to take more prudent adoption decision than those who have limited information. We can also assume that information at various extent and sources may confuse a potential adopters as well. Receiving information from various sources may make individuals become dilemmatic to make decision (Granovetter, 1982). Therefore, what extent various type of information has been shared is also important to understand the diffusion process.

2. 7 Sources of Information

Scholars argued that sources of information rather than the amount of information has greater impact in the technology dissemination process (Rogers, 1983; Burt, 1983 ;). Information acquisition from others is constrained by the nature of relationship between a recipient and a donor of information (Shah, 1998). Trust, confidence, similarities etc between the actors are reported as the reason behind information exchange (Roloff, 1991; Morrison 1993, Coleman, 1957). There are generally two categories of communication channels through which individuals seek or receive information. These are – a) mass media like TV, radio, newspaper etc. and b) interpersonal channels or social networks. Studies found that in small town and rural areas information flows through interpersonal contacts rather than mass media like TV, news papers, radio, internets etc (Menzel and Katz, 1956). Because, interpersonal channels provide social support and confidence in suggested outcome (Albrechat and Adelman, 1987) and it helps the intended adopters to handle personal needs and situation specific judgments (Schramm, 1973). Therefore, the adoption behavior depends from where the information has been received or who sent information to whom.

2.8 Social Networks or Social referent for information sharing

In the process of technology dissemination, information sharing by the adopters is considered as social networks (Valente, 1995). Individuals receive and forward information from and to their social network partners like friends, relatives, neighbors, co-workers etc. Diffusion studies suggest that once an individual adopt the innovation, he/she pass the information to the non-adopters or once an individual adopted the innovative technology, it becomes a source of observation and learning for other non-adopters (Valente, 1996, Granovetter and Roland, 1983, Coleman et al, 1957). Social network members or social referents of an individual exercise influence over decision maker and can use their network position to promote or add legitimacy to information (Valente, 1995; Coleman et al, 1957; Menzel, 1960; Rogers, 1983; Menzel and Katz, 1956; Becker, 1970; Granovetter, 1982; Burt, 1987).

Three types of information and information activities are important in the technology dissemination process as mentioned above. Observation is an indirect technique of acquiring information (Shah, 1998). Observation in other sense is a one way information flowing process, a monitoring activity. The hearing and discussion both activities are direct techniques of information processing and two way information flow (Shah, 1998). In both cases, actors inquire about the innovative technology or being informed and advised about the innovation. The differences between these two types of information seeking activities are that each information activity is concerned with particular phase of adoption process and also the content of information differs in these two information

seeking activities. All these information seeking activities create social networks among the adopters or in other words, individuals' social referents may change in accordance with information seeking activities. Individuals may depend on various others or networks partners to obtain various kind of information. Moreover, all types of information obtained through different activities have various advantages and disadvantages in terms of availability, securities, efficiency and competence etc. (Asford and Cummings, 1983; Morrison and Bies, 1991). Therefore, in the diffusion of innovation, selecting social referent for each types of information is important components that may influence the adopter's adoption decision.

But now the question is that who is adopter's social referent and in which occasion? Who receives what type of information from whom or who passes what type of information to whom? Diffusion studies, specifically social network studies found that individuals are influenced by many actors in the social system or networks (Festinger, 1954; Janis, 1982; Salanick and Pfeffer, 1978). For example, Valente (1995) argued that since an individual could not follow the adoption behavior of all others in a system or society, he/she follow the behaviors of others with who he/she has direct contact. Granovetter (1973) on the other hand showed that people receive information about new job from others with whom he/she has weaker personal ties or social bondage as because strong ties prohibits infiltration of new ideas and provides only redundant information. Burt (1987) argued that medical drug adoption by the doctors is governed or restricted within the group members who are in structurally similar position in the network but they may or may not direct contacts with each other. Ibarra and Andrews mentioned the information exchange process has been accelerated by the strength of cohesive ties and conformity pressure. Members of a cohesive group exhibit greater behavioral conformity than those in less cohesive groups (Levine and Moreland, 1990). Therefore, individual social reference in respect of acquiring information is more multi facet. An individual are informed by various actors and also from various sources. Based on the social network theory, we examine two the role of two social network groups -

2.8.1 Cohesive group or network –

The cohesive group is determined by the degree of interpersonal contact or tie. An individual may have various direct and indirect social ties with others in a network or in a community, but his cohesive group is comprised by those with whom he/she has the highest social interaction. A graphical representation may help us to understand this group segregation more comprehensively.

Figure – 2.2 Categorization of Groups based on Cohesion in a Social Network

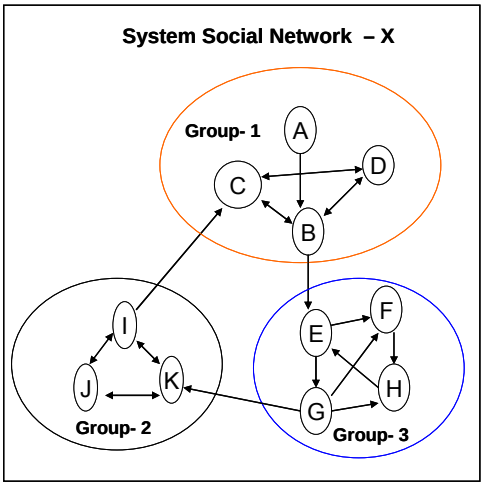


Figure 2.2 shows that there are 11 individuals in the social network X. Various direct and indirect social ties are present or absent between the individuals. Based the degree of connectedness, individuals are categorized into 3 groups. In each group, it is not necessary that all the members have to have direct contacts with each other. For example, all the members of group 2 are connected with each other, but all the members of group 1 and 3 are not

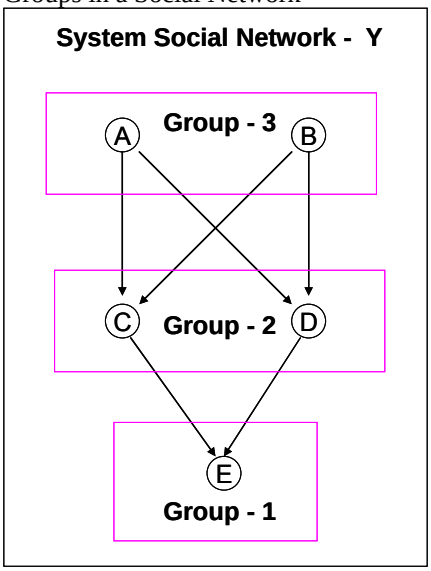
connected with each other. However, an individual belongs to that very group in which he has higher number social ties than in any other groups. For example, Actor G has direct contact with actor K, but they belong to different group, because, actor G has 2 network with the members of Group – 3, only 1 network with group 2. Same rule also apply to actor B and actor K. later we will mention more precisely about method of cohesion group identification in social network approach.

The cohesive research states that frequency, intensity and proximity of interaction among cohesive members generates greater information sharing than it does among non-cohesive members and therefore, cohesive group offers opportunities to learn about an innovation and also impose constraint among the members to adopt about an innovation (Ibarra and Andrews, 1993; Shaw, 1998). If a member of a cohesive group learns about an innovation, this information may quickly be passed or forwarded to the other members of that particular cohesive group as because the members of a cohesive group enjoy higher degree of connectivity among them (Ibarra and Andrew, 1993, Levine and Moreland, 1990). On the contrary, Granovetter (1983) argued cohesive group prohibits infiltration of news ideas and it only provides redundant information. Cohesive groups were found to influence members' attitude formation towards new job and innovative technology (Kilduff, 1990; Krackhardt and Kilduff, 1990; Rentsch, 1990; Rice and Aydin, 1991). Rice, Grant, Schmitz, and Torobin (1990) also found that stronger social networks influenced the technology adoption decision.

2.8.2 Structurally Equivalent group

Structural equivalent actors are those who share a similar pattern of relationships (from and to) with others and thus occupy the same position in a network. For a better explanation, consider the example in Fig. 2. 3. On the law of structural equivalence, 5 actors of social network Y have been divided into three groups. In this graph actors C and D are structurally equivalent since both ties to actor E and both have ties from actor A and B. In addition, actor A and B are structurally equivalent because both have ties to C and D. Structurally equivalent actors into a single subset and representing them together as a single structural entity called an equivalence class or position. Importantly, the members of a structurally positioned group or class members may or may not direct ties with each other. (Although distinct construct structural equivalence and cohesion is not mutually exclusive).

Figure – 3 Structural Equivalent Groups in a Social Network



Structural equivalence theory invokes that people are influenced by others with whom they share similar position in the network. Social environment, competition, socialization process all has be defined under the structural equivalence theory. For example, Burt (1987) showed that the competition exists between two actors who share a similar position in the social network and competition serves as a direct mechanism of influence on adoption behavior. Others research showed that indirect relation is kind of social

environment which provides similar opportunities and constrains to the individuals belong to same position in a society or community. Marsden and Friedkin (1994) suggested that structural equivalent actors may influence each other via indirect ties to similar others from whom they adopted similar attitude and beliefs. Catwight (1965) refer to this process as an ecological influence. Actors become similar given similar environmental circumstances. Shared experiences and socialization among structural equivalent actors shape their behavior similarly.

2.8.3 Spatial group and Social referent

Individual's behavioral similarity can be identified on the basis of geographical proximity. People live in similar geographical boundary or tertiary share common values and emotion and thus geographical proximity renders the social contagion process (Rogers, 1983). Physical proximity allows the individual to observe, learn other experiences and to share ideas and values of each other, which not only help an individual to become aware of an innovation, or to reduce risks by witnessing the consequences of adoption, but also neighborhood peers' adoption behavior create social pressure on the individual (Burt, 1987). Rogers (1983) empirical study also shows how the process of solar-system dissemination in a town has been influenced and guided by the physical proximity among the neighborhood members. Samaddar and Okada (2007) have also found that individuals live in the same neighborhood have greater social interaction and their adoption behavior is channelized through social learning and social influence generated due to co-neighborhood membership.

2.9 Information Sharing and Characteristics of Adopters and Innovation

In the diffusion of the innovation, information sharing activities are subject to adopters' characteristics and attributes of innovation (Becker, 1970, Coleman et al., 1957, Rogers, 1983). Socio-economic characteristics like age, educational attainment, economic well being, cosmopolitanism etc. create constrains and opportunity to have access to information and also their adoption behavior. The extent and manner information shared between the individuals also depend on socio-economic affiliation and attachment. The content and manner of information exchange in the diffusion process also depends on the invention characteristics, specially the adopter's level of satisfaction. Suggestion and advice about an innovation is passed from the early adopters to the late adopters may vary what extent the users are satisfied in respect of hardware and software components of an innovation (Rogers, 1983). An individual who is very satisfied with the innovation may like to pass positive information to other likeminded individuals or if they are dissatisfied they may become abstain from passing any information to others or they may discourage others to adopt. Therefore we also examine the adopters' socioeconomic characteristics, and their level of satisfaction.

2.10 Social Network Model of Organization

The above described approaches broadly focus on more of macroscopic views of social network development and information sharing activities in the dissemination of innovation. In particular, it shows how the development of social networks helps the individuals or adopter to reduce uncertainties or risk to make adoption decision. However, these approaches are unable to find the importance of social network formation at organization level which may help to move or to implement the innovative idea or technology from the inventors to the end users. The importance of organizational structure is not well answered from the above discussion.

Addressing the issue, Okada and Kobayashi (1989), later modified by Okada (1993), introduced a Network Model of Organization. In this model, an organization or a region has been considered as a "field" where there are many actors who play distinctive role in order to make the organization or the region more functional. The model calls this as "Creative Forum" which a region or organization can set up for collective action in order to cultivate the benefit of an innovative idea or technology. In this regard, the model compares the structure of an organization with the functioning of brain. To make a organization creative and effective, it is proposed that the 'brain's function' have increasingly been required to be moved from the top or center of an organization to its ends or 'hands'. In other words, the ends of the organization are acquiring more of its brain-related functions and fewer of the functions of its hands that are totally subject of its brain (See Figure 2.4). Therefore, there is a required demand of shifting focus from a hierarchical or vertical structure of the organization to the horizontal or network structure of organization. Fig. 2.4 compares these two types of organizational structure. The former concentrates crucial information at the top and then conveys information from the top to direct those further down below. In contrast, the latter allows those who are at peripheral locations to act autonomously in the generation, accumulation, processing and dissemination of information to a reasonable extent.

The Model assumes that there are nine players in this game. Each Player is an individual or group who is assumed to be an independent decision maker. However, in practice various players' role could be performed by the same individual or group. The game takes the form of communication interplays performed by the players. The players start the game by interacting with one another to form and expand their own communication network. The list and description of the each player are as follows -

Initiator (I) - this is a creative individual or group who invents some novel idea or new form of technology. He is assumed to initiate this game by arousing awareness about his invention. However, Inventor may not always become the initiator in reality. Therefore, it needs to make a distinction between inventor and initiator where they are not identical.

Comrade (C) – is an individual or group who shares the goal of bringing the invented idea or new form of technology into being and assists the initiator in this effort.

Appreciator (A) – is individual or group who appreciates the value off the invention. Appreciating the value and potential impact of the new idea, this player influences other players to accept and implement such innovative idea.

Director (D) – is an individuals or group who directs the process of dissemination of new idea or technology. The crucial role of the directors is to reduce the uncertainty concerned with the new technology adoption as well as to solve the conflicts among the players for the proper implementation of the technology.

Technical Supporter (T) – is an engineer person or group who stays outside the core team formed by the initiator, comrade and director. This player supports the core team by offering them any vitally important engineering skills which do not posses.

Circulator (CR) – the circulator is an individual or group who literally circulates the information about the invention among the players. His role is not only to disseminate

the information or news among the individuals, but also to reply the player's own assignment of the innovation.

Financier (F) – The financier is an individual or group who offers financial assistance to the initiators or to the core team. Raising fund is critical factor which determines the success of creative development.

User (U) – The user is an individual or group who makes decision about whether or not to adopt the creative enterprise as a novel product. This player performs an important role in judging whether the novel product truly meets his potential needs.

Imitator (IM) – the imitator is an individual or group who starts to imitate the novel product by gaining information about it and then producing the technology necessary for duplicating the product.

Table 2.1 Matrix representing the phase of participation in innovation

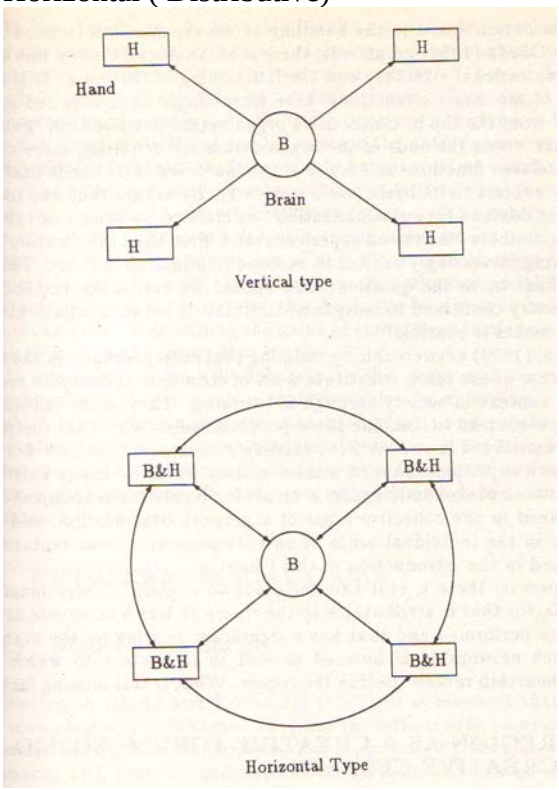
	Pre-Invention	Pre-adoption								Post-Adoption		
Players	Embryogeny	Invention	Awareness	Interest	Study	Trails	Adoption	Adaption	Implementation	Diffusion	Obsolescence	Decay

Fig. 2.5 illustrates the structure of the game viewed as a set of communication interplays performed by the above-defined nine players. Table 2.1 shows how the commitment of the players can be categorized during the different phases of innovation.

2.11 Conclusions

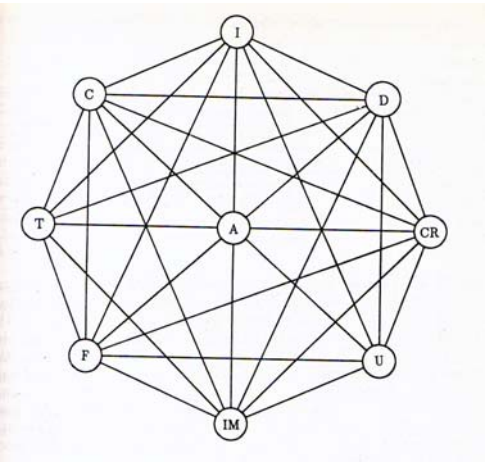
In this chapter two types of social network approaches been mentioned. The first approach focuses more on the network among anonymous individuals or adopters. It has been found that to examine the impact of social pressure and social influence on the adopters, the social networks may be taken into consideration at an adopter's personal level and also at his community level. Individuals may be influenced by both levels of the social network. The above reviews have shown that three types of information are required for adopters to reduce the uncertainty of adoption decision. Individuals receive all types of information from various sources, like structural equivalent group, cohesive group or from their socio-economic group members, etc. Therefore, it is instrumental to examine the pattern of three types of information sharing activities and also to examine who are adopter's social referents or sources to acquire information. At the end, the two alternative approaches of social networks show the necessity of examining the organizational structure and network development process in order to find out the constrains and opportunities of the organization to create an environment or filed which may help the innovation dissemination.

Fig. 2.4 Vertical (Hierarchical) vs. Horizontal (Distributive)



Source : Okada , 1993

Fig. 2.5 General Skeleton of the Communication Network Model



Source : Okada , 1993

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Chapter – 3 Modelling and Analysis of Rainwater Harvesting Technology Dissemination Process Based on Social Network Threshold Model

3.1 Introduction

This chapter deals with the rainwater harvesting technology dissemination process in the coastal areas of Bangladesh. Since an innovation is new to a community, the adoption decision of an innovation to an individual is subject to uncertainty (Rogers, 1983). Learning from other experience by sharing knowledge and information through social interaction reduces this uncertainty (Becker, 1970, Granovetter, 1983) and thus may change the probability of adoption decision of individuals. Sharing information by the members of a social system creates a chain of social network that helps the members of the system to take a collective decision about the new idea. An individual may learn and be influenced from both personal or neighborhoods and system networks or regions, and may be both of these networks have distinctive impacts on an individual's adoption decision making process. Based on the Social Network Threshold model, this chapter attempts to specify the adopter's degree of innovativeness in respect of system or region level and personal or neighborhood network level to understand the effects of macro and micro level networks on rainwater tank adopters in Coastal Bangladesh.

3.2 Drinking Water Pollution Risks by Arsenic in Bangladesh

Arsenic contamination of groundwater in Bangladesh has become the biggest natural calamity in the world. Millions of the populations are expected to experience a slow and painful death from arsenic poisoning over the next decades unless they are provided alternatives to drinking contaminated well water (Bearak, 1998; Smith et al. 2000; Hadi, 2003). Though the actual number of population drinking arsenic contaminated water is still unknown (Hadi, 2003), an estimated 40 million people of Bangladesh are drinking arsenic contaminated water (UNICEF: 2006), and about 70 million people of 59 districts out of 64 districts are at risk (Safiuddin and Karim, 2001). Arsenic poising is manifested primarily in skin lesions on the palms of the hands and soles of the feet and chronic exposure can cause adverse health effects including skin and lung cancer (Hopenhayn-Rich et al. 1998.). The actual cause of arsenic contamination is yet to determine, but it is widely believed that this serious water problem can be attributed to the extensive use of groundwater for drinking and irrigation purpose in the rural areas since the 1960s. Creating innovative ideas and technologies and implementation of such technologies is inevitable to fight with drinking water pollution risks.

3.3 Challenges of Implementing Innovative Technology for Arsenic Prevention

Rainwater harvesting technology is recognized as such an innovative technology that reduces and prevents drinking water pollution risks. Therefore, implementation or dissemination of rainwater harvesting technology at a wider level is instrumental to cope with such drinking water risks. One of the major challenges for such technology implementation is that communities are unfamiliar with the new technology (Smith, Lingas, and Rahaman, 2000; Caldwell et al., 2003). Hadi (2003) mentioned that it took many years to convince people of Bangladesh to use tube-well water which is free from pathogenic microorganism. Now, when 97% of the country's population depends on tube-wells for drinking water, it is a great challenge to convince the people again to reject tube-well with which they become habituated, and also it is hard to believe for them that this apparently crystal clear water is responsible for disease and death.

Moreover, a trust must be generated among the local community that the new innovative technology must not create similar problem in future as it happened in case of tube-well (Smith, Lingas, and Rahaman, 2000;). Previous studies have found that several innovative technologies have been invented and designed for arsenic reduction, but the biggest challenge for implementing such innovative technologies is public awareness and acceptance of the technology by the local community (Jakariya et al., 2003; Haque et al., 2004). In many cases, different Governmental and Non-Governmental organizations offer and suggest local communities to adopt different technologies for arsenic prevention. As a result, offers of various arsenic preventive technologies from various sources make the local community become puzzled and confused to select the appropriate technology that may suit for them (Akmam and Higano, 2007; Haque et al., 2004). Therefore the adoption of rainwater tanks by the community members become the challenge to the local community itself.

3.4 Case Studies

3.4.1 Rainwater Harvesting Initiatives in Coastal Bangladesh

In the arsenic affected rural and urban areas of Bagerhat district in Coastal Bangladesh, the rainwater harvesting technology has been practicing since 1999 to create alternative drinking water sources. In the present study context, rainwater harvesting movement in two Upazilas (sub-district) of Bagerhat district have been discussed below -

Morrelganj Upazila **-** Rainwater harvesting technology was first introduced in this Upazila in 1999 by the joint initiatives a local NGO, namely “Community Development Center” (CDC), a nation based NGO, namely “NGO-Forum”. In the initial phase, the rural areas of ‘Morrelganj Upazila’ (sub-district) were targeted under this programme. In order to create alternative drinking water source, the progamme aim was to build few tanks for the poor households in some selected villages by providing financial subsidy, so that seeing those tanks may encourage the neighboring households and local communities to install the tank by their own cost. Under this programme, the beneficiary pays the one third of the cost and the rest of the money is covered by the NGO.

In 2004 when “People for Rainwater” (PR) from Japan joined hand with the local NGO, the project expanded from rural to urban areas, and as a result the Morrelganj Municipality, the only municipality in this sub-district, was also covered under the programme. Since then, instead of providing finical subsidy, microcredit scheme was introduced for the promotion of rainwater harvesting practice, particularly among the poor people.

To promote rainwater harvesting technology, several awareness campaigns were undertaken by the local NGO. Courtyard meetings, “Para” meetings were organized to demonstrate the existing drinking water pollutions risks and the role of rainwater tanks for reducing such risks. A village development committee was formed in each village and neighborhood. The technological support along with a micro-credit scheme was offered to the beneficiaries to install mini rainwater tank with a capacity ranging from – 1500 liters to 4400 liters for a household. The cost of a tank ranges from 9000 to 14000 Taka (130 - 200 US$).

Chetalmari Upazila **-** In Chetalmari, another arsenic affected Upazila(sub-district) of Bagerhat district, the similar rainwater harvesting tank was started to install by the joint initiative of a local NGO, namely Gano Milan Kendra (GMK), and “People for

Rainwater"(PR) from Japan since 2005. Like Morrelganj Upazila, micro-credit scheme was introduced for the promotion of such practice. Till date, 42 tanks in 15 villages have been installed from June, 2005 to August, 2008. There is no fixed size of the tank; however, it varies from 2500 liters to 5000 liters. Though the cost of the tank is quite high, it is relatively low than the cost of the tank in Morrelganj Upazila.

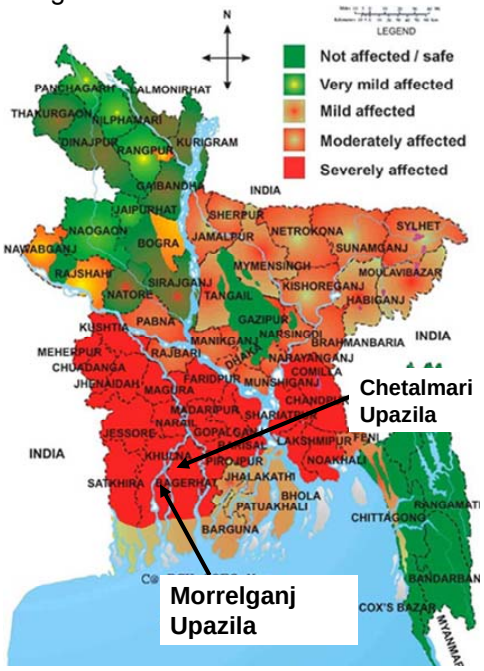
Table 3.1 shows a brief of the rainwater harvesting initiatives in those above mentioned areas

Table – 3.1 A Brief Description of the Initiatives of Rainwater Harvesting in Coastal Bangladesh

	Rural Areas of Morrelganj Upazila (Sub-district)	**Morrelganj Municipality**	**Chetalmari Upazila**
Implementing Agency	Community Development Center (CDC), NGO- Forum, People for Rainwater (PR)	Community Development Center (CDC), People for Rainwater (PR)	Gano Milan Kendra (GMK), People for Rainwater (PR)
Target Group and Area	Area affected by arsenic contamination and water salinity. Socially and economically impoverished people	Area affected by arsenic contamination and water salinity. Socially and economically impoverished people	Area affected by arsenic contamination and water salinity. Socially and economically impoverished people
Project Period	June, 1999 to August, 2007 (On going)	June, 2004 to August, 2007 (On going)	January, 2005 to August, 2007 (On going)
Number of Tank Installed (By August, 2007)	57 (Including the tank of NGO workers)	53 (Including the tank of NGO workers)	46 (Including the tank of NGO workers)
Project Area	Villages of Morrelganj Upazila (Sub-District)	Morrelganj Municipality	Villages of Chetalmari Upazila (sub-district)
Total number of Village/ Town under the programme intervention	18 villages	1 Municipality (8 Neighborhoods)	8 villages
Tank Capacity	1200 liters, 1500 liters, 2000 liters, 3200 liters, 4400 liters	1200 liters, 1500 liters, 2000 liters, 3200 liters, 4400 liters	No fixed size of the tank. Tank size range – 3000 liters and 5000 liters.
Tank Cost	8000 Taka to 14000 Taka (130 - 200 US$)	8000 Taka to 14000 Taka (130 - 200 US$)	6000 Taka to 11000 Taka (90 – 160US $)

Micro Credit Scheme	The Scheme was introduced since 2004 to promote rainwater harvesting practice among the poor people. Half of the cost of the tank is covered under the scheme.	The Scheme was introduced since 2004 to promote rainwater harvesting practice among the poor people. Half of the cost of the tank is covered under the scheme.	The Scheme was introduced since 2005 to promote rainwater harvesting practice among the poor people. Half of the cost of the tank is covered under the scheme

Map 3.1 Arsenic Contaminated district of Bangladesh



Picture 3.1 Rainwater Harvesting tank Installed in Morrelganj Upazila

3. 4.2 An Overview of the Study Areas

Rural Areas of Morrelganj Upazila – Rainwater tanks have been built in 17 villages of 4 *village unions* (A 'Village Union' consist of several villages and a 'Upazila' (sub-district) consists of several 'Village Unions') in the western part of Morrelganj 'Upazila'. In an average, the villages are located 8 to 10 kms away from the Morrelganj municipality, the only urban settlement in this Upazila (sub-district). Agriculture and fishing is the main source of income of these rural communities. The region has been suffering from drinking water pollution due to arsenic contamination of ground water along with water salinity. The major source of drinking water is pond, and a few households use tube-well. Moreover, poverty makes the community become more vulnerable. Each village of the region is unique in its own way; however, often the socio-economic activities of the local communities cross the administrative and geographical boundary of village. A brief of the area is given in Table 3. 2.

Table – 3. 2: A overview of the of 'Village Unions' of Morrelganj Upazila (Sub-district) where the rainwater tank has been introduced

	Village Union				
	Baruikhali	**Nisanbaria**	**Baharbania**	**Khuolia**	**Jiudhara**
Number of Villages under the Programme	7	4	1	1	4
Number of tank installed	32	17	2	3	6
Total Households	6618	5898	4986	6969	5792
Literacy rate	69.64	57.76	63.11	57.13	62.81
% of Households having direct source of income from agriculture	51.17	61.30	57.12	56.66	63.73
Sources of Drinking water (in %) -					
Tap	2.66	1.46	1.59	2.52	.78
Tube-well	9.78	5.54	10.44	19.10	4.51
Well	2.10	4.49	2.52	2.21	3.44
Pond	84.38	88.33	84.80	71.61	89.35
Other	1.08	0.17	0.64	4.51	1.91
Arsenic affected Tube-wells	42	100	4	16	3

Sourc**e: Census of Bangladesh, 2001;** Morrelganj Upazila Karjalay, 2003:

Morrelganj Municipality - 'Morrelganj' municipality, seemingly an overgrown village, comes under the jurisdiction of 'Bagerhat' district (See Map 3.1), is also highly arsenic prone area. The populations of 22 thousand earn their livelihood mainly from (See Table 3.3) small trading, business, governed services and agriculture and fishing based occupations (Samaddar and Okada, 2008). Muslims are the numerically dominated ethnic religious group in the town, however, a small number of Hindu communities are also observed. In the present study context, it is important to note that though the town is divided into 9 administrative jurisdictions, called wards, town settlements are socially and spatially more distinctive in the name of "Para" or neighborhoods. Each "Para" is comprised by a homogeneous group of individuals who share a strong sense of belonging based on religion, kinship ties, and occupation etc that separate a group of individuals from other. Each "Para" or neighborhood is occupied by a particular community, for example - 'Serestadarbari': inhabitants of the Hindus; 'Kuthibari': mainly occupied by school teachers; 'Uttarsaralia': inhabitants who migrated from similar region; 'Bazarpara': meaning market place, mostly occupied by businessmen etc. Therefore, the individual's attitude and behavior is considered to be controlled and governed by the "Para" in a great extent. It was reported that 58 tube-wells in the 'Morrelganj' municipality are arsenic contaminated (Samaddar and Okada, 2008).

Table 3 .3 An overview of Morrelganj Municipality

	Morrelganj municipality
Number of tank installed	53 (Including 4 NGO members household)
Total No. of Households	4378
Population	21718
Literacy Rate	71.28
Religion (in %)	
Muslims	87%
Hindus	13%
Major Sources of Income (in %)	
Agriculture	15.37
Non-agricultural laborer	7.40
Business	38.71
Transport and Construction	4.86
Govt. Service	18.10
Others	15.12
Sources of Drinking Water (in %)	
Tap	11.89
Tube-well	52.29
Well	1.34
Pond	31.47
Other	3
Arsenic affected Tube-wells	42

Source : Census of Bangladesh, 2001; Morrelganj Upazila Karialav, 2003:

Rural Areas of Chetalmari Upazila - Chetalmari, another highly arsenic affected area, is located in the eastern part of Bagerhat district (See map 3.1). The villages of this Upazila which come under the water harvesting programme are mainly occupied by the Hindu community. Like Morrelganj Upazila, arsenic contamination and water salinity are the main drinking water population risks for the local community whose main sources of drinking water are tube-wells and ponds. According to the Census of Bangladesh, 2001, the literacy rate of the Upazila is 52.2% and more than 78% population is engaged in agricultural sector.

3. 5 Methods

3.5.1 Adopter Categories

To systematically understand the impact of social networks in rainwater tank adoption process in the coastal areas of Bangladesh, the Social Networks Threshold model is used in the present study. From a macroscopic point of view of the diffusion of the innovation, an individual's degree of innovativeness can be characterized in respect of the whole region or town. Here a focus is placed on timing of adoption over the whole process of innovation in the entire region (system). Thus in the modeling of the innovation process at the macroscopic (system) level, adopters are classified as- 1) early adopters, 2) early majority, 3) late majority, and 4) laggards (Valente, 1995). Early adopters are individuals whose time-of-adoption is greater than one standard deviation earlier than the average time-of-adoption. Early and late majorities are individuals whose time-of-adoption is bounded by one standard deviation earlier and later than the average. Laggards are those individuals who adopted later than one standard deviation from the mean.

On the other hand, from a microscopic point of the diffusion of the innovation, an adopter's degree of innovativeness can be characterized in respect of the personal network or neighborhood/village level. Here, the adopters are classified by partitioning the personal network thresholds distribution (Valente, 1995). Threshold is the exposure of an adopter at the time-of adoption and Exposure is the proportion of adopters in an individual's personal network at a given time (for details see Chapter 2). As mentioned above that in the small town, each neighborhood is occupied by a unique group of individuals. The members of a neighborhood share some common belongings in terms of culture, economic activities etc. Similarly each village of an Upazila (Sub-district) is unique in its own way. Therefore, in the present study, personal social network threshold has been altered into neighborhood or village network threshold and classified the neighborhood network adopters by following the model - Low network threshold individuals have neighborhood network thresholds one standard deviation lower than the average threshold. Low and high network threshold individuals have neighborhood network thresholds bounded by one standard deviation less than and greater than average. High network threshold individuals have neighborhood network thresholds one standard deviation greater than average. The average threshold is the mean threshold for the community.
Adopter categorization is created to determine the difference among adopters with respect to external influences, communication behavior and opinion leadership.

3.5.2 Opinion Leaders

Opinion leadership, considered as an informal leadership, is the degree through which an individual is able to influence the other individuals (Rogers, 1983, Valente, 1996). Opinion leaders in a sense are the opinion breakers who influence the adoption behavior of the members in a community. The opinion leadership score is determined by counting the number of times an individual was nominated as a network partner and to correlate this variable with innovativeness as measured by an individual's time of adoption of the innovation under study (Valente, 1995).

3.5.3 External Influence

Different scholars argued that the degree of innovativeness depends on the external influence and communication media (Rogers, 1983, Valente, 1995, Becker, 1970).

Cosmopolitan actions make individuals to become exposed to external influences. A cosmopolitan individual is oriented to the world outside of his/her social system and relates his/ her local social to the larger environment by providing links to outside information (Valente, 1995). The model tested here is that the role of external influences on adoption of innovation both at system level networks and neighborhood social networks.

3.5.4 Field Surveys

Field surveys were conducted in two phases both for 4 weeks duration –the first phase July to August in 2007, and the second phase January to February in 2008. The study covered all the 49 households in Morrelganj Municipality, 35 households in the rural areas of Morrelganj Upazila and 30 households in Chetalmari Upazila. The heads of the households, who are main household decision makers, were chosen as respondents, most of them male, except three female respondents in Morrelganj town who expressed that though they are not the head of the household, they took the major initiative and decision to install the rainwater tank. The interviews were conducted in the home of the respondents so that respondents can express freely and also it allowed other members of the households to provide additional information that could have been overlooked by the main respondent. Both structured and semi-structured interviews were conducted. Open-ended interviews include how they made the decision about rainwater tank, why they decided to install it, who motivated them, the consequences of their tank installation processes etc. An in-depth observation of adaptors socio-economic condition, their social relation with others, the condition of rainwater tanks and houses of the adopters were made. Apart from those, to follow the present network threshold models of diffusion of innovation, we collected data of – 1. Time (date) of adoption or installation of rainwater tank - were collected from the records of the NGO and later, the data were crosschecked by asking the respondents to recall their time of rainwater tank installation. 2. Opinion leaderships – were collected by asking the adopters to name three tank adopter in their town to whom they often turn for advice and suggestion in daily life. 3. External influence or cosmopolitanism – was measured by the number of visits to the nearest large city, 'Khulna' within a year; reading newspaper; watching TV, monthly income and level of education.

3.6 Results

3.6.1 Dissemination Pattern of Rainwater Harvesting Technology

Morrelganj Rural - Since 1999, only 57 tanks have been installed in 17 villages of 4 village unions in Morrelganj Upazila (See Table 3.4). Tanks have been installed in vast geographical territory, but diffusion is concentrated in some particular villages. Moreover, after a certain period, the dissemination has almost stopped, except a few scatted developments. For example, Table 1 show that among the 17 villages, only in 3 villages including Pailatola and Goalbaria village in Baruikhali union, and Hogolpati village in Nisanbaria union, a significant number of tanks have been installed, and after 2003 there is no significant development of tank installation took place. It seems that at a particular time, a particular village or its surrounding villages have been selected by the NGO to install rainwater tank, but after such intervention, the development of tank installation is negligible in almost all cases. For example, in Hogolpati Village 10 tanks were installed in between June, 2002 and July, 2003, but afterward only 1 tank has been built in this village. Same trend has been observed in case of Goalbaria and Pailatola village. The

tank installation rate is not only slow, but sparsely distributed over a vast track of geographical territory.

Table – 3. 4 Tank Installation in the rural areas of Morrelganj Upazila

Name of Village & Village Unions	**Year and Month of Tank Installation**																	**Total**
	1999		2000		2001		2002	2003	2005			2006			**2007**			
	06	**07**	**06**	**07**	**06**	**08**	**06**	**07**	**05**	**07**	**08**	**01**	**10**	**11**	**05**	**06**	**08**	
Tetulbaria			1						2									**3**
Pailatola	3	3								1	1						1	**9**
Uttar sutalori					1	1				1		1		1				**5**
Dakhshin Sutalori	1						1											**2**
Goalbaria			3	4	1													**8**
Basanda						2												**2**
Haritokitola															1			**1**
Baruikhali Union	**4**	**3**	**4**	**4**	**2**	**3**	**1**	**0**	**2**	**2**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**30**
Vashandal						1											1	**2**
Hogolpati							7	3					1					**11**
Guyatola													1					**1**
Badshyarhat						1												**1**
Nisanbaria Union	**0**	**0**	**0**	**0**	**0**	**2**	**7**	**3**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**15**
Baharbiunia		1															1	**2**
Baharbania Unio	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**
Sannashi																3	1	**4**
Khuolia Union	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1**	**4**
Bhaijora										1								**1**
Jiudhara					1						1							**2**
Paschim Bisharighat										2								**2**
Harindhara										1								**1**
Jiudhara Union	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**6**
Total	**4**	**4**	**4**	**4**	**3**	**5**	**8**	**3**	**2**	**6**	**2**	**1**	**2**	**1**	**1**	**3**	**4**	**57**

Morrelganj Urban - Over the 39 months period of time, starting from June, 2004 to August, 2007, 49 households, excluding the NGO workers, have installed rainwater tank in 8 neighborhoods of Morrelganj town. Table – 3.5 shows that though the diffusion of the rainwater tank took 39 months in total to diffuse among 49 households excluding the NGO workers' households, yet the diffusion process or rainwater tank adoption took place in 17 phases or months and significantly in some phases, the adoption of rainwater tank is concentrated sharply in some particular neighborhood. For example, the rate of tank installation in the year 2004 in 'Serestadarbari' neighborhood is quite high, whereas, the trend of tank installation in other neighborhoods is negligible during that phase. Similarly, a good number of tanks were adopted in 'Uttarsaralia' neighborhood during May, 2007 to August, 2007. Secondly, the adoption of rainwater tank followed a steady and consistent rate of movement in some neighborhoods like 'Kuthibari', 'Serestadarbari', however, in other neighborhoods like 'Collegepara', 'Swadhinpara', 'Baruikhali' have lack of such growth. Thirdly, though few neighborhoods such as 'Swadhinpara' and 'Collegepara' started to adopt rainwater in the early phase of diffusion, but it failed to follow and maintain in the later phase of diffusion and in contrary, the neighborhoods like 'Purbasaralia' and 'Uttarsaralia' started diffusion phase quite afterward but a higher number of adoptions are observed(Table -3.5).

Table –3. 5 : Tank installation in various neighborhoods of Morrelganj Municipality

Neighborhoods	2004				2005						2006	2007						Total
	Jun	Jul	Aug	Nov	Jan	Feb	Apr	Jun	Jul	Aug	Oct	Feb	Apr	May	Jun	Jul	Aug	
Kuthibari		1		-	-	1	-		2	1	-	-	3		1	1	-	**10**
Baruikhali	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	**2**
Purbasaralia	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	3	**6**
Collegepara	-	-	-	-	-	-	2	-	-	-	-	-	-		-	-		**2**
Uttarsaralia	-	-	-	-	-	-	-	-	1	1	-	-	-	3	1	2	1	**9**
Bazarpara	-	1	-	-	-	-	1	-	-	1	-	1	-	-	-	1	1	**6**
Swadhinpara	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	**3**
Serestadarbari	1	1	2	1	-	-	-	1	1	-	-	-	1		3	-	-	**11**
Total	**3**	**3**	**2**	**1**	**1**	**1**	**3**	**1**	**4**	**3**	**1**	**1**	**4**	**6**	**5**	**5**	**5**	**49**

Chetalmari Upazila

In this Upazila, the diffusion process started from 2 to 3 villages and later on tanks have disseminated in the surrounding villages, particularly in the last few months of 2007 (see Table 3.6). However, a significant number of tanks have been installed only in two villages including Khalishpur and Sahoshpur. A few villages like – Surigati, Roygram installed tank in the very beginning of the dissemination process, however, tank installation literarily stopped to diffuse afterward in those village. On the other hands, in the villages like Kharamkhali, Pachpara, Captola, rainwater tank has been introduced very recently. Broadly the nature of tank dissemination is dispersed.

Table –3.6 Tank Installations in the rural areas of Chetalmari Upazila

Villages	2005				2006		2007									**Total**
	01	03	04	05	11	12	01	02	04	05	06	07	08	09	10	
Khalishpur	3	2	1							3	1	1	1	1		13
Sarecarani							1								1	2
Surigati		1														1
Roygram			1								1					2
Sahoshpur				1	1			1	1			1	2			7
Singa						1						1				2
Kharamkhali												1			1	2
Satospur					1	1	1									3
Kamargati												1				1
Paikpara												1				1
pachpara															2	2
Mandra																
Shibpur																
Garibpur																
Captola												1				1
Boalia														1		1
Total	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**7**	**3**	**2**	**4**	**38**

4.6.2 Cross-tabulation Analysis: Regional as a whole

Morrelganj Rural - Table 3. 7 shows the cross tabulation of various tank adopters in rural areas of Morrelganj Upazila. From this table following can be pointed out –

1) 73.69 % of adopters belong to very low threshold category. It indicates that once the tanks have been installed in one village, the tank has not disseminated in the same village. Only in case of few villages, tanks have been installed after the first project intervention. For example, 15.78 percent of tank adopters belong to very low threshold category of very early adopter phase (row 1, column 1, table 3.7), but in this early adopter phase there is no adopter in any other threshold category. Quite similar trends have been found in case of other phases of adoption.
2) More than 50% of the tanks have been built in early adopter phase and early majority phase (row 1 and 2, column 5, table 3.7). Therefore, in the very early stage of the dissemination, the tank installation rate was quite high, but over the period of time the tank installation rate has decreased significantly.
3) It seems that learning from NGO workers or from outside sources, a particular section of individuals in each village adopted the tank. But their tank installation did not create any social influence or social learning for the other village members. As a result no new members of those villages adopted the tank. In this regard, NGO workers have reported the following points during the field study – in the initial phase of the programme, it was quite tough to convince the villagers about the potentiality of the tank. Most of the villagers refused to install the tank, even though they were offered financial subsidy, i.e., 2 third of the cost of the tank, to install the tank. Only a few rich villagers, comparatively literate and cosmopolitan group of individuals of the village, realized the importance of the tank and accepted NGO's proposal. In a way, in the very beginning of the programme, only an affluent group of individuals in some villages adopted the tank after

getting financial subsidy. Once few group of the villagers have adopted the tank by getting financial subsidy, the other villagers then realized the importance of it by observing and hearing from the tank owners or in some case by drinking rainwater. Thus they became motivated to install the tank. But still, they wanted to install the tank only by getting financial subsidy. But in the mean time, the NGO has already stopped to provide financial subsidy. Therefore, only a few villagers are ready to install the tank without getting financial subsidy. The NGO sources reported that due to transportation problem, it is not feasible to provide this facility for a few number of households in all villagers. Therefore, only those villages or households who are relatively well connected through the main road, the tank has been installed by the NGO in the later phase of the dissemination process. As a result more than 70% of the adopters belong to very low threshold category.

Table – 3.7 Proportion of rainwater tank adopter categories in the rural areas of Morrelganj Upazila based on innovativeness relative to whole region and innovativeness relative to village level

	Village Network				**System Total**
System Networks	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters	**15.78**				15.79
Early Majority	35.09		1.75	3.51	40.35
Late Majority	12.28		**5.26**	7.02	24.56
Laggard	10.53			**8.77**	19.28
Village Network Total	73.69		7.01	19.30	100

Morrelganj urban - Table 3.8 shows the cross-tabulated distribution of various rainwater tank adopters in the whole region with reference to both the system networks and neighborhood networks. The following can be pointed out:

1) 12.24% (row 1, column 1, Table 8) of individuals adopted the rainwater tank when none of their neighborhood networks partners and community members had initiated to adopt the tank. They might have learned about rainwater tank from mass media, change agents like NGO, or from individuals outside the town. However, once the tank has been introduced by some adopters, the diffusion of rainwater tank adoption does not tend to gain enough momentum immediately, rather the growth rate in this early adoption phase (row 1) declines as it shifts from very low threshold adopters (row 1; column 1) to very high threshold adopters (row 1; column 2, 3 and 4). It seems that the tank adoption process at the very beginning early adopters phase was not concentrated in any particular neighborhood or social group, rather the adoption diffused in various neighborhoods. Our study found (not shown here) that in the very first phase of the diffusion (row 1, column 1, Table 8); the rainwater tanks were adopted by 6 individuals or households living in 4 different neighborhoods.
2) More than 50 percentage of adopters in this diffusion process belong along the diagonal of Table 8, that implies that majority of the individuals who adopt when their system and neighborhood network level exposure are about the same. Moreover, they (diagonal cells) scored higher in each phases of adoption, except late majority phase. To borrow the logic of Valente (11), it can be presumed that majority of the adopters obeyed

the social network of the neighborhood. In other words social innovation requires recognition to diffuse among the mass.
3) The remaining half took different behavioral patterns which are more diverse and biased. The upper triangle area (judged with respect to the diagonal axis) represents adopters who are categorized as comparatively innovative relative to timing in the system. For example, in row 1 column 2 of Table 3.8, adopters are innovative relative to the system, yet waited until 12.24 percentages of adopters at their neighborhood social network adopted. In contrast, the adopters who belong to the lower triangle (judged with respect to the diagonal axis) are those who are comparatively innovative relative to the neighborhood. Similarly, in row 3, column 1, the adopters waited until some adopters at system level has adopted the tank; however, they introduced the tank in their neighborhood before anyone else.

Table – 3. 8 Proportion of rainwater tank adopter categories in the Morrelganj Municipality based on innovativeness relative to whole region and innovativeness relative to neighborhood level

	Neighborhood Network				**System Total**
System Networks	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters	**12.2**	6.1	2	2	11 (22.4%)
Early Majority	6.1	**10.2**	4.1	2%)	11 (22.4%)
Late Majority	4.1	8.2	**22.4**	12.2	23 (46.9 %)
Laggard	-	-	2	**6.1**	4 (8.2%)
Neighborhood Network Total	22.4	24.5	28.6	24.5	49 (100%)

Chitalmari Upazila – Table 3.9 shows the cross tabulation of various tank adopters in rural areas of Chetalmari Upazila. From this table following can be pointed out –

1) The adoption pattern is dispersed and skewed. Though the initial development of tank dissemination was quite high, the tank adoption almost stopped for a certain period and again it started to disseminate in the late majority phase. For example, 10.5 % of adopters (row 1, column 1, table 3.9) adopted the tank when none of their village members and regional members adopted the tank. This initiative may encourage other fellow villagers and as a result another 13.2 % individuals of low threshold category in the same phase adopted the tank. But afterward, for a certain period, the tank has neither disseminated in the same village nor in the new areas. As a result only 2 individuals have adopted the tank in the early majority phase.
2) In the laggard phase the proportion of adopter's distribution in all threshold level is quite high, except low threshold phase. It indicates that adoption not only concentrated in some particular villages, but it also started to diffuse in other surrounding villages. It seems that tank adoption by few individuals not only influences their own co-villagers, but also an inter-village information sharing networks has been developed in the last majority phase of the diffusion.
3) There is no adopter in the laggard phase; it seems that the diffusion has not been completed yet.

Table –3.9 Proportion of rainwater tank adopter categories in the rural areas of Chetalmari Upazila based on innovativeness relative to whole region and innovativeness relative to village level

System Networks	Village Network				**System Total**
	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters	**10.5**	13.2	-	-	9 (23.7%)
Early Majority	2.6	**2.6**	-	-	2 (5.3%)
Late Majority	21.1	2.6	**23.7**	23.7	27 (71. 1%)
Laggard	-	-	-	-	-
Neighborhood Network Total	13 (34.2%)	7 (18.4%)	9 (23.7%)	9 (23.7%)	38 (1000%)

3.6.3 Analysis of Local Characteristics: Village and Neighborhood Level

Adopters in all the areas are broadly affluent section of the community. In the district where 47% of population are in below poverty line (Samaddar and Okada, 2008), the average income of the adopters in both the Upazilas (sub-districts) are quite high in respect of the local economy. All the adopters are literate and a good number of them are highly educated. For example, the literacy rate of the adopters in Morrelganj town is 100% and 42% adopters are having undergraduate level of educational attainment, whereas, only 71% of the town population is literate. Moreover, except Chetalmari rural areas, a higher percentage of adopters are engaged in non-agricultural sectors, even in case of rural areas of Morrelganj Upazila, an agricultural based area. As mentioned in the above section that when the tank was proposed to install by the NGO in the rural areas of Morrelganj Upazila, only a affluent section of individual in each village accepted the proposal and relatively poor households refused to install it as they thought the innovative rainwater harvesting technology may not serve their purpose and it is risky to invest money for that. It also indicates that since the cost of the tank is quite high, the poor people of the area can not adopt the tank even after they have learned from their co-villagers or neighbors that the tank is effective to reduce drinking water risks. On the other hand, adopters are by and large a homogeneous group of individuals in terms of household size family type, income and occupation. Therefore the tank disseminated only among the affluent group of individuals in the locality and adopters are by and large homogeneous group of individuals.

Table – 3. 10 Socio-economic Characteristics of Adopters

	Morrelganj Rural	**Morrelganj Urban**	**Chetalmari Rural**
Age			
Average Age of the Head of the household	50 (Sd.11.20)	47 (Sd.11.50)	42 (Sd. 13.28)
Maximum	78	78	75
Minimum	35	26	21
Household Size			
Average	6 (Sd.3.47)	5 (Sd. 2.65)	6 (Sd. 2.38)
Maximum	22	13	13
Minimum	3	2	3
Family Type			
% of Nuclear Family	68.6	63.3	50
% of Joint Family	31.4	36.7	50
Religion			
% of Hindu	97.1	30.6	97
% of Muslim	2.9	69.4	3
Education			
Literacy rate (Heads of the Households)	100	100	100
% of Primary education (Class 4)	11.4	0	20
% of Junior High School education (Class 8)	34.3	0	40
% of Secondary education (Class 10)	14.3	6.1	16.7
% of Higher Secondary Education (Class 12)	17.1	34.7	13.3
% of Undergraduate (Class 15)	20	42.9	6.7
% of Graduate (Class 17)	2.9	16.3	3.3
Household Income			
Average Monthly Household Income (In Taka)	13086 (190 US$)	17776 (260 US $)	8650 (126 US $)
Maximum observed income	40000	45000	20000
Minimum observed Income	4000	5500	2000
% of Up to 5000 Taka monthly Income	20	0	33.3
% of 6000 taka to 10000 Taka monthly Income	40	32.6	36.7
% of 11000 taka to 20000 Taka monthly household income	20	42.1	30
% of 21000 taka to 30000 Taka monthly household income	14.3	16.3	0
% of 31000 to 40000 Taka monthly	5.7	6.1	0

household income			
% of More than 40000 taka monthly household income	-	2	0
Occupation			
Agriculture	11.4	0	50
School Teacher	25.7	40.8	20
College Teacher	2.9	8.2	0
Govt. Service	28.6	12.2	0
Business	31.4	28.6	20
Others	0	10.2	10

3.6.4 External influence and Cosmopolitan Nature of Adopters

All the adopters are highly cosmopolitan in the entire region as shown in Table 3. 11. Comparatively the adopters of Morrelganj town are more cosmopolitan than the adopters of other regions. Therefore tank has disseminated not among the adopters who are socio-economically affluent group of individuals, but also they are relatively cosmopolitan in respect of the local status. Adopters in all of the regions have higher income, higher education attainment; a majority of them are having TV set and mobile telephone and they often go to the nearest largest city.

Table – 3. 11: Cosmopolitan Nature or External Influence of the Adopters

	Morrelganj Rural	**Morrelganj Urban**	**Chetalmari Rural**
Socio-Economic Status			
Education	10	12	10
Income	13086 (190 US$)	17776 (260 US $)	8650 (126 US $)
Cosmopolitan Nature			
% of Telephone Holders	97.2 %	100%	76.7 %
% of Households having TV	77.8%	100%	63.3 %
Visiting Nearest City (In a Year)	15.8	20.06	12.17
Media Consumption			
Average News Paper Reading Score (In a week)	2.27	5.47	2.57
Average Watching TV Score (In a week)	4.97	6.27	3.8

Table 3.12 shows the correlation between adopters' degree of innovativeness and their nature of cosmopolitanism. The following point can be derived –

1) There is no association between external influence and degree of innovativeness both at system and neighborhood/ Village level in case of Morrelganj Urban areas, except a low association between city visits and system level innovativeness.

2) Though the correlation is not significant, but a low level of correlation is found between external influence and degree of innovativeness in case of Chetalmari Upazila. Both system level and regional level and Village level innovators have low level of

positive correlation with their income, educational attainment and watching TV and reading newspaper score in the rural areas of Chetalmari village. Therefore early adopters irrespective of the region and village level, have higher cosmopolitan nature.

Table – 3. 12: **Correlation between Cosmopolitans and Innovativeness**

	Morrelganj Urban		**Chetalmari Rural**	
	System Level	Neighborhood Level	System Level	Village Level
Socio-Economic Status				
Education	-.127	.063	-.30	-.252
Income	.044	.134	-.321	-.277
Cosmopolitan Nature				
Having TV	.008	.052	-.261	-.069
Having Mobile Phone	NA	NA	-.196	-.141
Watching TV	-.065	.009	- .265	-.115
Media Consumption				
Reading Newspaper	.043	-.240	- .272	-.294
Visiting City (Khulna)	-.334*	-.220	-. 202	-.216

* P<0.05

The most innovative adopters, i.e., all the early adopters in respect of system have higher external influence than the system level adopters. Similarly, very Low threshold adopters in all phases have higher external influence than higher level threshold adopters.

Since there is low level of correlation between degree of innovativeness and cosmopolitan nature in case of Chetalmari Upazila, Table 3.13 helps to recheck the role of external influence or cosmopolitan nature with tank adoption by cross tabulating the cosmopolitan score of all the adopter in more detail . Table 3.13 shows that the adopter in very early adoption phase has comparatively higher income and educational attainment than the other adopters in early adopter and early majority phase (column 5, table 3.13). Moreover, the most innovative adopters , i.e., very low threshold adopters of early adoption phase (row 1, column 1, table 3.13) are having highest external influence, except income level, than any adopters in the diffusion process. They often go the nearest city, read newspaper quite everyday in a week. Whereas, the most late adopters, i.e., very high threshold adopters of late majority phase (row 13, 14, 15, 16, 17, 18; Column 3, table 3.13) have the lowest cosmopolitan score. It seems that economic well being and educational attainment helped the innovators to take away the tank installation risks and to comprehend its importance and effectiveness quite earlier than the others. Similarly, since they have higher external contact, it helped them learned about the tank from mass media or outside sources before their co-adopters. The Late adopters on the other hand due to their economic constrains could not take the risk of tank installation and presumably wait until some of their network members adopted the tank to become certain about the effectiveness of the tank.

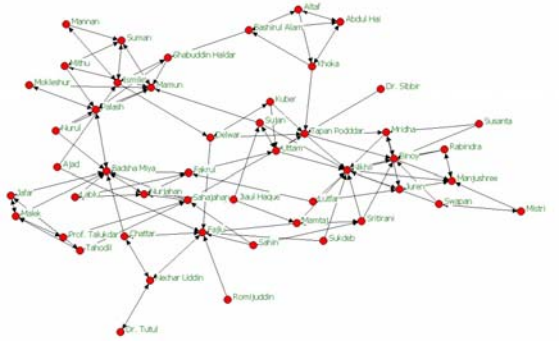
Table – 3. 13 : Coprolite Score of adopters in respect of their regional level and village level in the rural areas of Chetalmari Upazila.

	Village Level Network				**System Total**
	Very Low Threshold	**Low Threshold**	**High Threshold**	**Very High Threshold**	
Early Adopters					
Education	10.25	10.50	-	-	10.37
Income	10750	12000	-	-	11375
Visiting City	20	12.25	-	-	16.12
Watching TV	7	4	-	-	5.50
Reading Newspaper	5.25	2.50	-	-	3.87
Early Majority					
Education	-	4	-	-	4
Income	-	10000	-	-	10000
Visiting City	-	0	-	-	0
Watching TV	-	0	-	-	0
Reading Newspaper	-	0	-	-	0
Late Majority					
Education	9.25	17	7.1	7.6	8.1
Income	9250	15000	6812	6500	7548
Visiting City	13	12	13.25	8.25	11.23
Watching TV	3.75	1	2.87	3.87	3.33
Reading Newspaper	3.50	7	.37	2.75	2.19
Laggard					
Education	-	-	-	-	-
Income	-	-	-	-	-
Visiting City	-	-	-	-	-
Watching TV	-	-	-	-	-
Reading Newspaper	-	-	-	-	-
Neighborhood Network Total					
Education	9.75	10.50	7.12	7.62	8
Income	10000	12166	6812	6500	8650
Visiting City	16.50	10.16	13.25	8.25	12.16
Watching TV	5.37	2.83	2.87	3.87	3.80
Reading Newspaper	4.37	2.83	.37	2.75	2.56

3.6.5 Analysis of Effects of Opinion Leadership

Adopters' interpersonal contact influences their adoption decision and also interpersonal contact or social networks help them acquire information of an innovation. Theoretically, individuals who receive higher opinion leadership score are potential to receive more information and also the idea of an innovation diffuses from them to the other members of the community. Since in case of Morrelganj Rural, the most of the adopters installed in the first phase of the diffusion, it is not relevant to examine the correlation between interpersonal contacts or opinion leadership scores and tank dissemination process. Thus, the present study focuses on Morrelganj Urban and Chetalmari Rural areas. It is found that interpersonal contacts among the adopters do exist in both case study areas as graphed in Fig. 3.1 and Fig. 3. 2. Fig 3.1 shows that there is no isolated adopter, rather all the adopters are well connected with each other in Morrelganj town. Similar trend has been found in case of Chetalmari rural areas (Fig 2), though there are few isolated individuals. It seems that in both cases interpersonal contact or opinion leaders influence the diffusion process. The correlation between opinion leadership score and degree of innovativeness may help to find out explicitly the innovation dissemination process in those study areas. Field surveys included information on opinion leaders who are determined by counting the number of times an individual was nominated as a network partner. It is intended to correlate this variable with innovativeness as measured by an individual's time of adoption of the innovation under study.

Fig. 3.1 Interpersonal contact in daily life among the adopters in Morrelganj Town.



Adopter → Tie

Toggle Label – Adopter's Name

Fig. 3. 2 Interpersonal contact in daily life among the adopters in the rural areas of Chetalmari Upazila

Adopter → Tie

Toggle Label – Adopter's Name

Morrelganj Urban - Let us take a look at the most innovative not only in respect to the system level, but also in respect of their personal or neighborhood network (row 1, column 1). Those who adopt the technology early and to decide with very low network thresholds are more likely to be opinion leaders. For example, tank adopters who adopt

very early relative to both system level and personal network (row 1, column 1) received an average 5.17 nomination by others in Table 3.14, as compared to very early adopters with highest network thresholds (row 1 , column 4), who received only 1.42 network nomination. Those laggards with the highest network threshold (row 4, column 4), received a very low nomination score. These findings are considered basically consistent with the expected characteristics stated above. Opinion leadership by earlier adopters suggests that from opinion leaders to the rest there is some flow of interpersonal influence acting within the social system. More specifically, the early tank adopters of 'Morrelganj' town became opinion leaders in their community and may have circulated information and influence about rainwater tank dissemination to other neighborhoods. The later adopters thus gained more information or reassurance about rainwater tank effectiveness from the early adopters.

2) The highest scores in opinion leadership were mostly received by the adopters who are identical both in respect to the system level and neighborhood level, along the diagonal of the table, except in laggard phase (row 4, column 4, Table 3.14). One may interpret as follows. Opinion leaders are considered to behave in a normative fashion or tend to maintain community norms and thus influence others.

Table 3. 14 Opinion leadership score (number of networks nominations received) by system level and neighborhood level in Morrelganj Town

	Neighborhood Networks				
System Networks	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	**System Total**
Early adopters	**5.17**	4.67	0	1.42	4.18
Early majority	2	**2.2**	2	0	1.91
Late majority	0.5	3.25	**3.91**	0.84	2.69
Laggards	-	-	2	**1**	1.25
Neighborhood Networks Total	3.45	3.16	3.26	0.82	2.73

Chetalmari Rural – in this region, early adopters irrespective of their threshold level have received higher opinion score (Table 3.15). It indicates that information flow from the adopters who adopted in the phase to the late adopters and it may diffuse across the village boundary. Therefore, observing or hearing from the early adopters or innovators, the individuals of same village as well as outsiders have adopted the tank. Seemingly, tank dissemination took place through social learning rather than social pressure and social influence.

However, in the late adopter phase, low threshold adopters have also received a significant opinion leadership score. It seems that they may have good social ties with the early adopters from whom they have learned about the tank and also after their tank adoption they pass the information to the potential adopter which may have created a potential ground for the tank diffusion.

Table 3. 15 Opinion leadership score (number of networks nominations received) by system level and neighborhood level in the rural areas of Chetalmari Upazila

System Networks	Village Networks				
	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	**System Total**
Early adopters	**2.5**	3.25	-	-	2.87
Early majority	-	**0**	-	-	0
Late majority	1	3	**1.37**	.62	1.10
Laggards	-	-	-	-	-
Neighborhood Networks Total	1.75	2.67	1.37	.62	

3.6.6 Complementary Behavioral Analysis at Neighborhood Level, Morrelganj Town

As pointed out in the previous model analysis (see Table 3.8), in Morrelganj town early adopters tended to be sparsely distributed and rather isolated, but found widely across different neighborhoods in the whole region. Therefore, they do relatively little in exercising social influence and social learning required for the diffusion of the technology. Likewise, since the innovators were sparsely distributed in different neighborhoods, adoption behavior of isolated innovators seemingly did not receive proper recognition by the neighborhood social norms; rather presumably they were treated as an isolated action. As a result, the innovators adoption initially might not make social influence on innovators' social network partners. Such connotation of social learning and social influence in regards of adoption pattern may not be detained significantly in the present study model, yet during filed study, it is found that 4 out of 6 innovators were partially involved with the NGO's rainwater recycling movement as a leader of the 'Village Development Committee' (VDC) formed under the awareness campaign program for alternative drinking water source. Being attached with NGO's movement not only enhanced knowledge of those innovators through social learning, but also provided a social support and social recognition of their action. Even sparsely distributed in vast geography and social territory, the early innovators could build social webs between them in virtue of their affiliation with a wider social platform, entitled here as NGO, that was required to initialize the innovation in their own neighborhood. However, it took time to get recognition from the neighborhood peers until the benefit and utility of new alternative drinking water source was observed. In this regard, two such related field notes at below received from two innovators may support the above judgment. Nikhil Chandra Halder, the first adopter in 'Serestadarbari' neighborhood informed us – "Since I was a leader of VDC of the NGO in this neighborhood, I used to discuss and share with other members and common people about various social and environmental problems. When CDC launched this rainwater tank program, I along with other NGO staffs used to organize 'Utanh Boithok' (courtyard meeting), 'Para-Meeting' (neighborhood meeting) to demonstrate and aware people about the rainwater tank. Then I realized the importance of rainwater tank and I also realized that since I am asking other neighbors to install this tank , I must install it first so that people can learn from me, otherwise it is not good, you know, you are asking others but you yourself are not following, and then people will not listen you. So I installed it. In the beginning nobody cared about that, but once some of

my neighbors observed it and drunk the rainwater, they realized and installed the tank, I mean, I must say at least this is happening in my neighborhood." Similarly, Fazlu Gaji, an innovator, residing in 'Bazarpara' informed – "Like the beginning of other NGO program, in this rainwater recycling program, I got a request from the CDC to join in the neighborhood meeting to convince people to use and install rainwater tank as an alternative drinking water source. Doing this, I learned about the rainwater tank and planned to install it. However, my family members and others neighbors suggested me not to install it as they thought it is expensive, we don't know its function properly, whether or not it will really serve our purpose etc. But since I learned that other wise persons, like Nikhil-master (Mr. Nikhil who is teacher) in 'Serestadarbari', Tahodil-Beapari (Mr. Tahodil who is a businessman) in 'Kuthibari', you must be knowing they were also VDC leader, is going to install this tank, I got confidence and decided to take it. And now, very interestingly, those who discouraged me, even my family members say this was really a wise decision."

3.6.7 Complementary Analysis of Distinctive Adopters, Morrelganj Town

As pointed out also in the previous finding, the adopters who belong to the upper triangle area in Table 3.8, regionally innovative in timing of adoption, and personally (neighborhood level) rather private network-oriented, thus not innovative in being able to decide alone, are the individuals who depend more on their neighborhood network partners to take adoption decision or in other words, they adopted innovation only once an innovative idea was brought into their personal social domain by someone. On the other hand, those adopters who belong to the lower triangle, personally innovative and socially late adopters are the individuals who depend more on system level than their personal or neighborhood network to make the adoption decision or in other words, they learned from other areas or neighborhoods about an innovation and then introduced it into their personal social domain.

Though reservation is needed, one may well interpret what factors are suspected to be involved behind the above findings. (a) Personal or neighborhood social networks which are developed through direct social and spatial interaction including friends, kin, co-occupants, neighbors etc. help an individual not only to become exposed to an innovation, but the adoption behaviors of other personal network partners create huge social pressure on co- network partners.

(b)On the contrary, at system level or regional level, an area-wide social network is considered to be developed through collection of individuals who have indirect ties loosely linked. This will serve as a social system to support individuals to learn or to become exposed about an innovation which may or may not prevail into his or her personal social domain. During our field surveys two such distinctive adopters described their adoption process.

(c)To quote the statement made in our interview by 'Juren Majumder', a school teacher living at 'Serestadarbari' neighborhood adopted quite earlier within the whole town, but adopted late relative to his neighborhood peers. He explained his adoption motive as - "Before my rainwater tank installation, 4 to 5 neighbors with whom I most often interact in daily life installed the rainwater tank. Seeing their tanks, my wife used to ask me everyday to install the rainwater tank. Because, you know, it was a matter of competition and prestige issue for us. Everyone installed, but we had not done yet. Everybody has good water, but we don't have. What may our friends think about us? Thinking that, I ultimately also installed". Another statement was made by 'Ismile', a bank employee living in 'Uttarsaralia' neighborhood first introduced this tank into his neighborhood, but a quite late adopter with respect to the whole town, described - "You know, the whole area has great dirking water problem , specially water salinity for long. I had been trying

to look for some alternative water source, in the mean time, one of my office collogue who live at 'Bhasandal' (another village) informed me that they had installed the rainwater tank which helps to get pure water throughout the year . They were very satisfied and strongly recommended me to install it immediately. Then, I talked with an NGO worker who is also my classmate and after that I took it. Even, you know, seeing my tank, a lot of people in this neighborhood had adopted as well".

3.7 Summary

By using the social network threshold model, our study has specified the adopter's degree of innovativeness in respect of system or region and personal or neighborhood network level that may help to understand the effects of macro and micro level network on rainwater tank adopters in the arsenic prone coastal Bangladesh. Based on the direct findings from the model's application the following implications have been derived.

In the rural areas of Morrelganj Upazila, once the tanks have been installed in one village, the tank has not disseminated in the same village. Therefore, in the very early stage of the dissemination, the tank installation rate was quite high, but over the period of time the tank installation rate has decreased significantly. It seems that learning from NGO workers or from outside sources, a particular section of individuals, particularly affluent and cosmopolitan group of households, in each village adopted the tank. But their tank installation did not create any social influence or social learning for the other village members. In addition, it was found that seeing others tank a few group of individuals was motivated to install the tank, but due to transportation problem it was not feasible for the NGO to provide such facility to the remote villages as the demand for tank was very few.

In case of Morrelganj town, in the initial phase of the diffusion of rainwater tank, the adopters sparsely distributed in various neighborhoods and as a result did not significantly contribute to the development of any personal network that is assumed to support or pressure on non-adopters. Accordingly the adoption process did not seem to achieve momentum. On the other hand, since a majority of adopters' system and neighborhood level exposure are about the same, it presumably indicates that diffusion of rainwater tank in this town followed the group norms. This may be interpreted as such that personal or neighborhood social networks which are developed through direct social and spatial interaction helped the adopters not only become exposed to an innovation but also create social pressure at micro level, eventually render the rainwater tank adoption process. Social system, on the other hand, may well serve as a platform for social support and learning for individuals about the tank. It may also be suggested that the adoption of innovative disaster measures is affected by the group norms and therefore, those individuals' adoption behaviors tend to follow the group norms, i.e., identical both at system level and personal level, they have been selected as informal leaders or opinion leaders. The earliest innovators irrespective of system level or personal level are likely to bring the innovative ideas into the community and then they diffuse to others through social interaction.

The adoption pattern of the rural areas of Chetalmari Upazila is dispersed and skewed. Though the initial development of tank dissemination was quite high, the tank adoption almost stopped for a certain period and again it started to disseminate in the late majority phase. In the last phase, adoption not only concentrated in some particular villages, but it also started to diffuse in other surrounding villages. It seems that tank adoption by few individuals not only influences their own co-villagers, but also an inter-

village information sharing networks has been developed in the last majority phase of the diffusion.

External influence on the adoption decision behavior has not been found to be so significant in all areas, except for the effect of visiting the nearest city, and reading newspaper which may suggest that in a small town mass media have very limited impact on the diffusion of innovation, rather information flows through inter-personal channels are likely to effect the process. However, it is important to note that the economic affluence as well as their higher cosmopolitan nature leads them to become motivated to install the tank.

The discussion of the chapter reveals and indicates the possibilities of correlation between social networks and information sharing activities which may or may not influence the dissemination process. However, the chapters has not touched upon which sort of information has been shared by whom, or the direction, nature and pattern of each type of information sharing activities required in the technology dissemination process are not explored. Based on the above discussion, the next chapter touches upon such issues.

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Chapter - 4: Extended Analysis of Rainwater Harvesting Technology Dissemination Process – Focusing on Social Networks of Information Sharing

4.1 Introduction

Like other innovative technology adoption, the adoption decision of rainwater tank is risky and uncertainties to the potential adopters or local communalities, because it is new to them. In the process of the dissemination of innovation, individuals seek and process information of the innovative technology to reduce suck risks and uncertainties (Valente, 1995; Coleman et al, 1957; Menzel, 1960; Rogers, 1983; Menzel and Katz, 1956; Becker, 1970; Granovetter, 1982; Burt, 1987). As a result innovation-decision process is considered as an information seeking and information processing development or activity (Rogers, 1983). The elements of information seeking activity that influence the diffusion of innovation are - types of information required for the innovation, the amount or extent of information individuals receive and forward, and also the sources of information based on which individuals take adoption decision (Valente, 1995; Coleman et al, 1957; Menzel, 1960; Rogers, 1983; Menzel and Katz, 1956; Becker, 1970; Granovetter, 1982; Burt, 1987). Based on the above theoretical foundation, to find out the role of information to accelerate the rainwater harvesting technology in arsenic affected coastal areas of Bangladesh, this chapter addresses the following research questions - 1) what kinds of information are required and in what extent for the individuals to make adoption decision? , 2) individuals depend on whom to obtain what kind of information? The soul aim of this chapter is to understand the social network development pattern of information sharing activities in rainwater tank dissemination process. The study took same case study areas as mentioned in chapter 3.

4.2 Types and sources of information in the technology dissemination process

To reduce uncertainty about the innovation, a comprehensive knowledge or information is required for potential adopters (Rogers, 1983). Now the question is what kinds of information are required or what types of information may make potential adopters to be certain about the innovation? Since an innovation is a technology, it consists of hardware and software components (Rogers, 1983). Comprehensive knowledge of both software and hardware components of the technology help individuals to make decision. An individual becomes exposed or informed to an innovation broadly through two ways – hearing from others and observing the innovation. Hearing, a two-way communication process, offers an individual to learn about the software components of innovation including function, utility, effectiveness, investment cost etc. of an innovation. On the other hand, observation is one-way communication process and it offers an individual to learn about the hardware components including shape, size, structure etc. Therefore, an individual' degree of knowledge or information about an innovation depend on what way he/ she exposed to innovation. However, technology adoption behavior is not an instantaneous activity, but it is regarded as a phased process which consists of – knowledge stage, persuasion stage, decision stage and implementation (Rogers, 1983).After knowledge phase, in the persuasion stage and decision stage, individual also may seek advice and suggestion from other sources to make a prudent decision. Discussing with others and getting suggestion from various sources also influence an individual's adoption behavior. Therefore examining three information sharing activities – hearing, observation and discussion are instrumental to understand the process of innovative technology dissemination.

Scholars argued that sources of information rather than the amount of information has greater impact in the technology dissemination process (Rogers, 1983; Burt, 1983 ;). Information acquisition from others is constrained by the nature of relationship between a recipient and a donor of information (Shah, 1998).But now the question is that who is adopter's social referent and in which occasion? Who receives what type of information from whom or who passes what type of information to whom? Diffusion studies, specifically social network studies found that individuals are influenced by many actors in the social system or networks. For example, Valente (1995) argued that since an individual could not follow the adoption behavior of all others in a system or society, he/she follow the behaviors of others with who he/she has direct contact. Granovetter (1973) on the other hand showed that people receive information about new job from others with whom he/she has weaker personal ties or social bondage as because strong ties prohibits infiltration of new ideas and provides only redundant information. Burt (1987) argued that medical drug adoption by the doctors is governed or restricted within the group members who are in structurally similar position in the network but they may or may not direct contacts with each other. Levine and Moreland (1990) mentioned the information exchange process has been accelerated by the strength of cohesive ties and conformity pressure. Members of a cohesive group exhibit greater behavioral conformity than those in less cohesive groups. Therefore, individual social reference in respect of acquiring information is more multi facet. An individual are informed by various actors and also from various sources. Therefore, it is instrumental to examine the individuals' sources of information or social referents. The present study attempts to examine adopters' social referent in three above mention information sharing activities. Sources of information has been examined in relation to adopters' economic, cultural , spatial and social network groups including cohesive and structural equivalent group as mentioned in chapter 2.

4.3 Methods

4.3.1 Description of Questionnaire Design

The present study is based on primary and secondary data. The case study areas and the respondent are same as mentioned in chapter 3. Focusing on the present study objectives, following additional survey questions were designed and data were collected –

1) Sources of information – were collected by asking the adopters to identify the sources from where they first time learn about rainwater tank. Two broad items were provided – a) mass media including radio, TV, newspaper, internets and b) interpersonal contacts including friends, relatives, co-workers, neighbors, acquainted, NGO workers etc.

2) Social networks of information seeking activities – to identify and map the social networks of information seeking activities; three types of socio-metric data were collected. Dividing the information seeking activities into three ways, respondents were asked to answer three survey questions – a) for social networks of hearing - "Kindly name us three persons from whom you first time heard about the rainwater tank"; b) for social networks of observation – " Can you remember where you first time observed the rainwater tank? If yes, kindly name us three places or houses of tank owners where you first time observed the rainwater tank"; c) for social networks of discussion- "Kindly name us three persons with whom you discussed or from whom you took suggestion, advice before your tank installation". Matrixes were formed for each types of social networks in such a way that cell entry Xij equaled one if actor i selected actor j for

particular interaction. For example, if actor i heard about the tank from actor j, the cell entries equaled one, and all other entries equaled zero.
3) General interpersonal contacts and social groups - Apart from above three socio-metric question items, to group the adopters according to their social ties, we collected socio-metric data on adopters' personal interaction in day to day life as mentioned in Chapter 3. (For this, respondents were asked – "kindly name us three tank adopters with whom you most often interact, meet and share sparse time in your daily life"). Matrix was formed same way as done for other social matrix. This matrix has been used to group the adopters into structural equivalent groups and also into cohesive groups. To conduct spatial groups of adopters, we used adopters' neighborhood affiliation records, and neighborhood affiliation matrix was formed accordingly.
4) To create social network matrix based on adopter's characteristics, – two broad sections of survey items were designed – 1) Cultural component includes religious affiliation of the adopters, 2)economic aspects includes income and occupation of the adopters.
3) Attributes of Innovation, and level of satisfaction of the adopters – data were collected on the hardware and software components of the tank, in this case, the relevant information were collected from the NGO who implemented this tank. Adopters' level of satisfaction is measured in respect of quality of water, tank capacity, tank design, shape, structure etc. Adopters were also asked to rank their overall satisfaction level. Hardware components of the rainwater tanks were examined through observation during field surveys.

4.3.2 Analytical Techniques

A number of analytical techniques were used in the present study. Each of the analytical technique is described briefly below –

Network Density – is the degree of connectedness in a network. It is measured by the ratio of existing links to the total number possible. In a directed graph, it is measured as - Density = T / (n – (n-1)).

Theoretically, higher network density graph provides higher possibility of information sharing among the actors. Thus, network density is associated with faster diffusion (Valente, 1995).

Degree Centrality – Two types of degree centrality have been used in this study. An individual's "In-degree" centrality is measured the number of nomination received, out-degree centrality is measured by number of nomination sent by the individual.

Centrality Betweenness – Betweenness" is a measure of how often a node (vertex) is located on the shortest path (geodesic) between other nodes in the network. It thus measures the degree to which the node under study can function as a point of control in the communication. If a node with a high level of betweenness were to be deleted from a network, the network would fall apart into otherwise coherent clusters. Unlike degree, which is a count, betweenness is normalized by definition as the proportion of all geodesics that include the vertex under study. If gij is defined as the number of geodesic paths between i and j, and gikj is the number of these geodesics that pass through k, k's betweenness centrality is defined as (Farrall, 2005):

$$\sum_i \sum_j \frac{g_{ikj}}{g_{ij}}, \quad i \neq j \neq k$$

Theoretically, a high centrality betweenness indicates that the individual acts as an intermediary between many others in the network. It indicates that the individual is a possible relay between many potential communicants in the network and that the individual may broker much relationship.

By using matrix of adopters' interpersonal ties in daily life, adopters have been categorized into structural equivalence and cohesive group.

A) *Structural Equivalence* – is determined by using a block modeling procedure, CONCOR (Convergence of iterated correlations), a subordinate found in UCINET. This positional clustering technique identifies groups of actor with relationships that are similar in terms of correlations between ties and divides them into blocks. Present paper divided the networks into 8 structural equivalent groups.
B) *Cohesive group* - The cohesive group was determined by using "Faction" techniques by running a computer programme of UCINET. The procedure is to partitioning of a binary network of adjacencies into n groups, then a count of the number of missing ties within each group summed with the ties between the groups gives a measure of the extent to which the groups form separate clique like structures. The routine uses a tabu search minimization procedure to optimize this measure to find the best fit. (See Appendix 3 for details).

E-I Index - techniques has been used to examine the degree of homogeneity of information sharing and adopters' group affiliation. E-I Index is the number of ties external to the groups minus the number of ties that are internal to the group divided by the total number of ties. This value can range from 1 to -1, but for a given network density and group sizes its range may be restricted and so it can be rescaled. A permutation test is performed to see whether the network E-I index is significantly higher or lower than expected. We used a computer programme of UCINET to measures such index.

We use UCINET's Quadratic Assignment Procedure (QAP) multi regression techniques to find out the actors' social referents for each kind of information seeking activities. This approach is similar to ordinary multiple regression; however, it enables analysis of matrix data. The equation used in this study is Y = Bo + B1 (Cohesion) + B2 (Structural Equivalence) + B3 (Neighborhood) + B4 (Religion) + B5 (Income) + B6 (Occupation).

4.4 Result

4.4.1 Types of communication channels

There is almost no role of mass media including TV, newspaper and internets in rainwater tank dissemination process in rural areas of Morrelganj Upazila as well as in Morrelganj town. Out of 35 interviewed adopters only 4 individuals in the rural areas of Morrelganj, and 6 individuals out of 49 interviewed adopters in Morrelganj town reported that they have learned about the tank from TV prior to their adoption. Though all the adopter are very cosmopolitan compare to the local community as found in chapter 3, but interestingly the influence of mass media on the adopters is negligible. It seems that either the local mass media has not covered such programme, or the adopters may have not paid attention to such information rarely covered by the mass media.

In case of Chetalmari Upazila, 9 adopters out of 31 interviewed adopters have learned about the rainwater tank from the mass media, especially from the TV, prior to their tank adoption. 5 individuals out of them are innovators in respect of the whole system, and

remaining 4 adopters are late adopters in respect of the whole region, but they are the innovators or early adopters in their own village. Therefore, mass media may have a moderate role in the early phase of tank diffusion process in Chetalmari Upazila.

4.4.2 Social Network Development Process of Information Sharing

Table 4.1 shows the role of various actors in three information sharing activities. In all three studied regions, adopters mainly heard about the rainwater tank from the NGO workers, but the involvement of community members or adopters increased in observation and discussion generated networks. To understand the pattern of information flow more explicitly, each study area is discussed below–

Table – 4.1 Role of different actors in providing various information (in %)

	Morrelganj Rural			Morrelganj Urban			Chetalmari		
	NGO	Outsiders	Community	NGO	Outsiders	Community	NGO	Outsiders	Community
Hearing	88.66	4.12	7.22	52.94	8.82	38.24	73.42	6.33	20.25
Observation	8.11	16.22	75.67	12.84	6.42	80.74	40	10	50
Discussion	88.66	7.22	4.12	8.62	6.90	84.48	21.16	5.77	78.85

Morrelganj Rural

Nearly all of the adopters became informed about the tank or heard about the tank from the NGO workers (see Table 4.1 and Fig 4.1), only a few network ties exist among the community members (Fig.4.2). In the initial phase of the rainwater harvesting programme, the NGO has targeted a couple of villages or a particular region under the awareness campaign programme. Individuals of those villages become informed about the rainwater tank by the NGO workers. Once the tank has been installed in some villages, these became a source of observation for the individuals of other neighboring villages where the tank was yet to build. As a result, Fig 4.3 and Fig 4.4 show that observation network do exist among the adopters in the rural areas of Morrelganj Upazila. Though the hearing networks ties do not exist among the adopters, it does not

Fig. 4. 1 Network map of hearing in Morrelganj rural (Including NGO workers and outsiders)

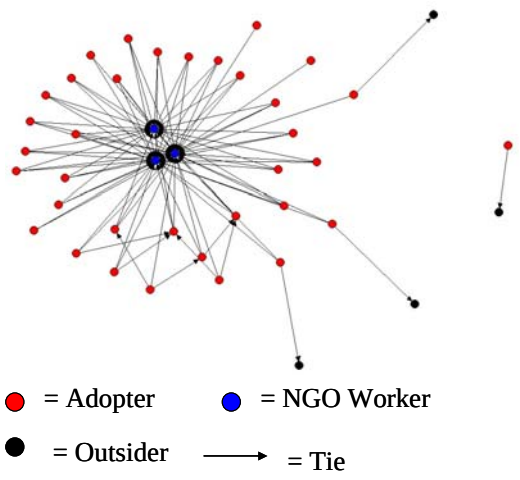
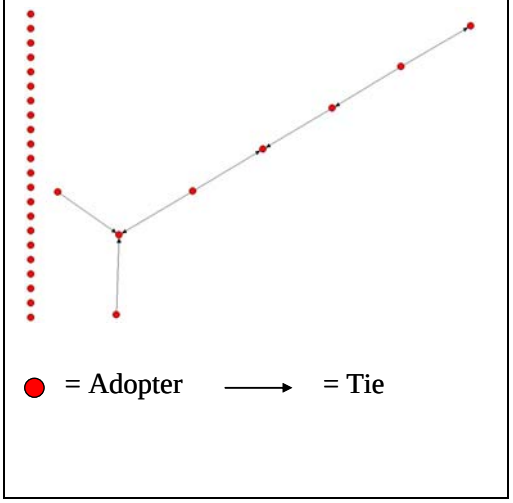


Fig. 4.2 Network map of Hearing in Morrelganj Rural (Excluding NGO workers and outsiders)



indicate that the adopters after their installation did not pass information to their network members or villagers. But on the contrary, it seems that adopters passed the information to their fellow villagers, but there were no potential adopters or in other cases the NGO did not make any further intervention in those areas as the demand of tank was very low which reduced the feasibility of further project intervention in same area as mentioned in chapter 3. In Morrelganj rural areas, the discussion network and hearing generated network are identical (not shown here). Since there were no early adopters in each village with whom the potential adopters could discuss about advantages and disadvantages of the tank, all the individuals selected hearing partners, NGO workers, as their discussion partners prior to their adoption. Therefore, social network may have developed and motivated the individuals to install the tank, particularly in the later phase of the dissemination. But since the NGO have taken away the programme from almost all of the villages, the implementation of the tank did not tank place.

Fig. 4.3 Network map of observation in Morrelganj rural including all the actors

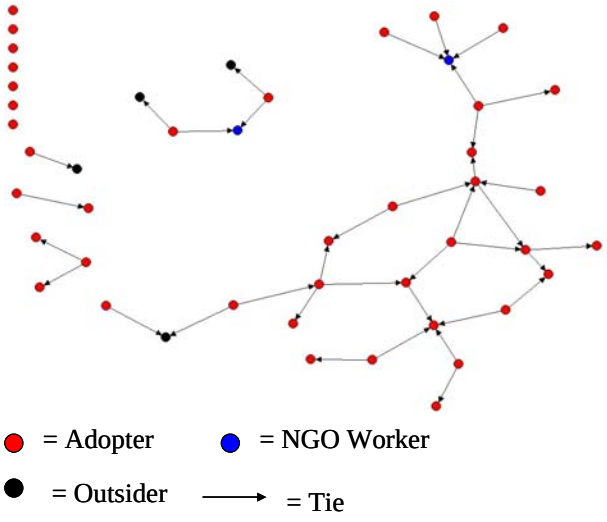
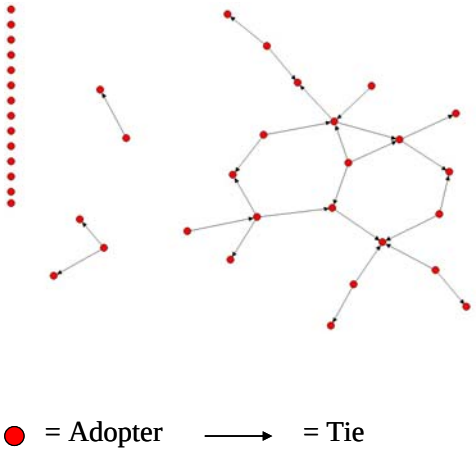


Fig. 4.4 Network map of observation in Morrelganj rural (only among the community members)



Morrelganj Urban –

The adopters of Morrelganj town mainly heard about tank from the NGO workers (Fig. 4.5), Like rural areas, in Morrelganj town the NGO workers under the campaigning progarmme went to the households to promote rainwater tank installation, and as a result the individuals first time came to know about rainwater harvesting tank from the NGO members. However, along with this campaigning programme by the NGO, the individuals heard about the tank from the community members who have already adopted it. As a result Figure 4. 6 shows that all the adopters are not passive recipients, but a good number of them took part in the information sharing process. Social networks of observation (Fig 4.7 and 4.8) and discussion (Fig.4.9 and 4.10) show that the involvement of community members increased in those two process. It seems that though the adopters mainly heard about the rainwater tank from the NGO workers, but tank installation by some individuals in the town may help the others to observe the tank to get a more comprehensive idea, like to know the structural aspects of the tank. In a way, tank installation by someone became a source of information for other non-

adopters. Social networks of discussion (Fig. 4.9 and Fig. 4.10) show that the adopters prefer to discuss with few members, but the community members or adopters are the central nodes of the network. Excluding the NGO workers and outsiders, the pattern of social networks in these three information sharing activities show that the observation networks is more dense than hearing and discussion generated network, but social networks of observation is more centralized as shown in Table 4.2. It indicates that there are few tanks which become sources of observation for many individuals. But, the owners whose tanks become source of observation may not be selected as hearing and observation partners by the individuals as because Table 4.2 shows that the discussion and hearing generated networks are more decentralized. Decentralized networks are those networks where information flows from various sources instead of concentrating in any particular nodes. Now the question is how such information network pattern influences the tank dissemination over the period of time.

Fig. 4.5 Network map of Hearing in Morrelganj Urban (Including NGO workers and outsiders)

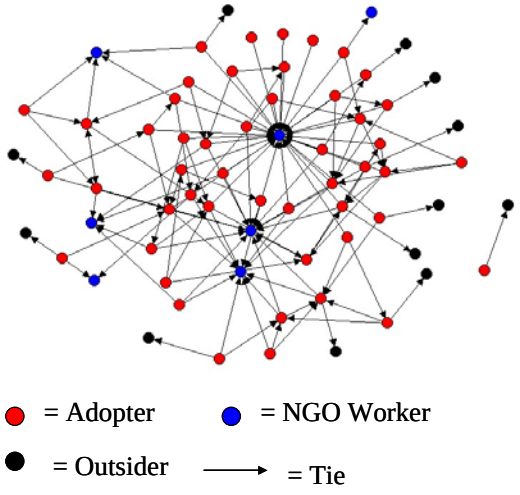


Fig. 4.6 Network map of Hearing in Morrelganj Urban (Excluding NGO workers and outsiders)

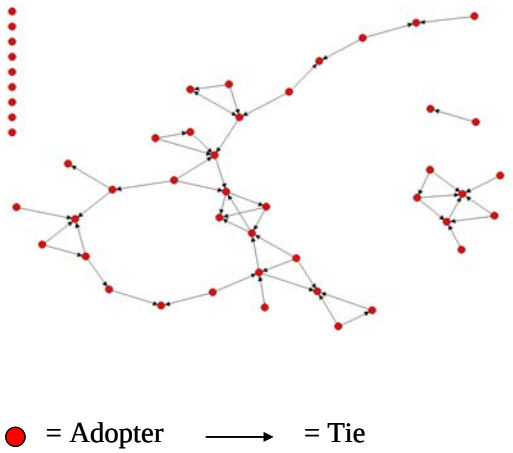


Fig.4.7 Network map of Observation in Morrelganj Urban (Including NGO workers and outsiders)

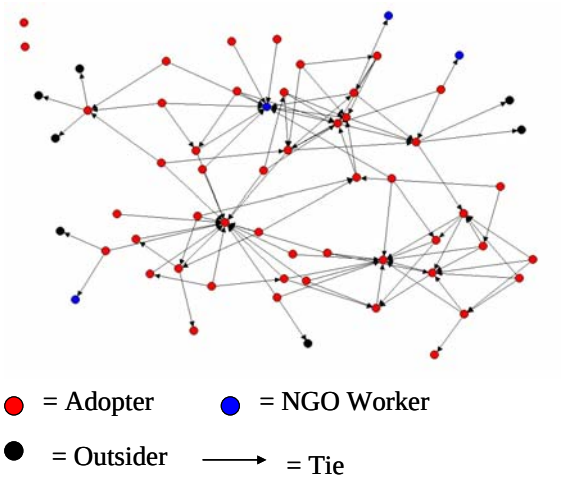


Fig. 4.8 Network map of Observation in Morrelganj Urban (Excluding NGO workers and outsiders)

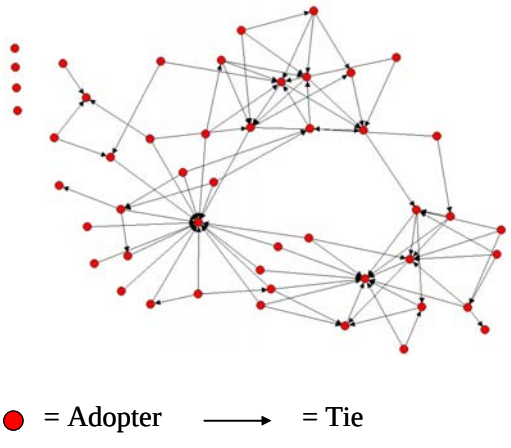


Fig. 4.9 Network map of Discussion in Morrelganj Urban (Including NGO workers and outsiders)

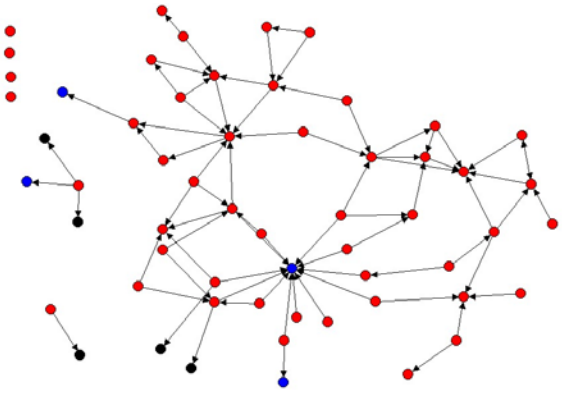


Fig.4.10 Network map of Discussion in Morrelganj Urban (Excluding NGO workers and outsiders)

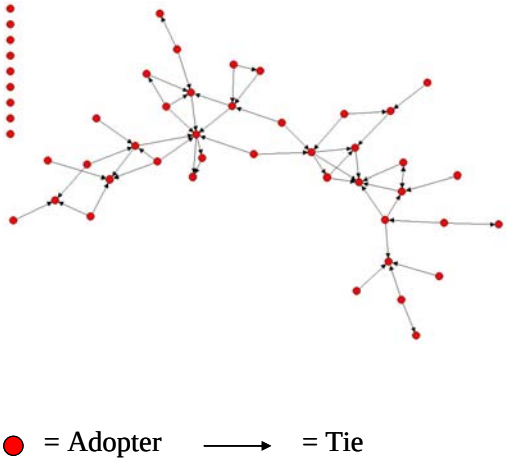


Table 4.2: Network Density and Centralization trends of Different Information Sharing Activities in Morrelganj Town (Excluding NGO workers and outsiders of the adopters)

	Hearing	Observation	Opinion
Social Network Density	0.022 (0.147)	0.037 (0.190)	0.023 (0.151)
Social Network Centralization	8.38	34.46	10.37

In Morrelganj town, there is no association between system level innovativeness and information sharing, except moderate correlation with observation activities (See Table. 4.3). Therefore, information was not passed by all the innovators or in other words a section of early adopters may be inactive to share information. For example, the very low threshold adopters of early adoption phase (row 1, column 1 , table 4.4) have higher in-degree centrality of all information sharing networks, but the other threshold level adopters (row 1, 3 ; Column 2, 3, 4; Table 4.4) in this phase have negligible or no role in hearing and discussion information sharing activities. Since there is a moderate level of correlation between system level innovativeness and observation outgoing degree centrality ($r = .39$; $p<0.01$), it can be said that those who adopted earlier in respect of the whole town, their tank become a source of observation for many others, though they may or may not took part in hearing and discussion activities. Moderate correlations are observed between neighborhood level innovativeness and information sharing activities (see table 4.3). It indicates not all, but a group of neighborhood level innovators have played significant role in all types of information sharing activities or in other words the individuals may have received information from their respective neighborhood innovators. As table 4.4 shows that very low threshold adopters and low threshold adopters of early adopter phase (row 1, 2, 3 column 1 and 2, Table 4.4) and early majority phase (row 4, 5, 6 and column 1 and 2, Table 4.4) played a significant role in all types of information sharing, however, the role of very low threshold adopter of late majority phase (row 7, 8, 9, column 1, table 4.4) is negligible. Therefore, adopters heard, and discussed about the tank from the neighborhood level innovators, but they observe the tank of system level adopters who installed the tank in very early phase of the dissemination. Overall, hearings and discussion networks have quite similar trends of information sharing pattern, but observation networks developed in a bit different manner.

Table – 4.3 Correlation between information sharing (out-degree centrality) and degree of innovativeness in Morrelganj town

	Hearing	Observation	Discussion
System/ Regional level	.09	.39**	.14
Neighborhood/ Village Level	.30*	.40**	.29*

** $p<0.01$, *$p<0.05$

Table – 4.4 Degree centrality score of all the adopters in various information sharing networks in Morrelganj town

System Networks	**Neighborhood Network**				**System Total**
	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters					
Hearing	2.17	.67	0	0	1.36
Observation	6	2.6	0	0	4
Discussion	2.33	1.33	0	0	1.64
Early Majority					
Hearing	.67	1.6	0	0	.90
Observation	1.3	2.4	3	0	2
Discussion	1.3	1	.50	0	.91
Late Majority					
Hearing	0	2	1.7	0	1.17
Observation	.50	1.7	1.3	0	.95
Discussion	0	1.75	1.81	0	1.17
Laggard					
Hearing	-	-	0	0	0
Observation	-	-	0	0	0
Discussion	-	-	0	0	0
Neighborhood Network Total					
Hearing	1.36	1.50	1.35	0	1.06
Observation	3.7	2.2	1.4	0	1.79
Discussion	1.63	1.33	1.50	0	1.12

The initiatives of early adopter or innovators in Morrelganj town helped the individuals or late adopters to directly receive various types of information, but neither regional level innovators nor neighborhood level innovators contributed in indirect flow of information among the individuals. Table 4.5 shows that the average betweenness centrality scores of very low threshold adopters (row 13, 14, 15; column 1) and early adopters (row 1, 2, 3 ; column 5) are very low, except a moderate score in observation information sharing. Table 4.5 shows that as the tank dissemination progress, the betweenness centrality score of the adopters increased, or in others words, relatively late adopters contribute in indirect information flowing. In particular, the individuals having low threshold in early majority phase (row 4, column 2, and table 4.5) and high threshold in late majority stage (row 6, column 3, and table 4.2) received the higher betweenness centrality score. They may work as a broker of information between two weekly connected groups of individuals. Therefore in the initial phase, a group of innovators directly informed to the selected number of individuals and afterward through the initiative of late adopters information disseminated indirectly between the adopters at a wider scale.

Table – 4.5 Betweenness centrality score of the adopters in various information sharing networks in Morrelganj town

System Networks	Neighborhood Network				System Total
	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters					
Hearing	.16	1	0	0	.36
Observation	0	7.3	0	0	2.15
Discussion	.67	.67	0	0	.54
Early Majority					
Hearing	0	7.6	0	0	1.17
Observation	.66	20.5	33.7	0	15.62
Discussion	1.33	0	0	0	.36
Late Majority					
Hearing	0	4.5	4.5	0	2.91
Observation	0	8	6.22	0	4.36
Discussion	0	3	4.63	0	2.73
Laggard					
Hearing	-	-	0	0	0
Observation	-	-	0	0	0
Discussion	-	-	0	0	0
Neighborhood Network Total					
Hearing	.09	4.91	3.50	0	2.22
Observation	.18	13.1	9.7	0	2.15
Discussion	.72	1.16	3.64	0	1.49

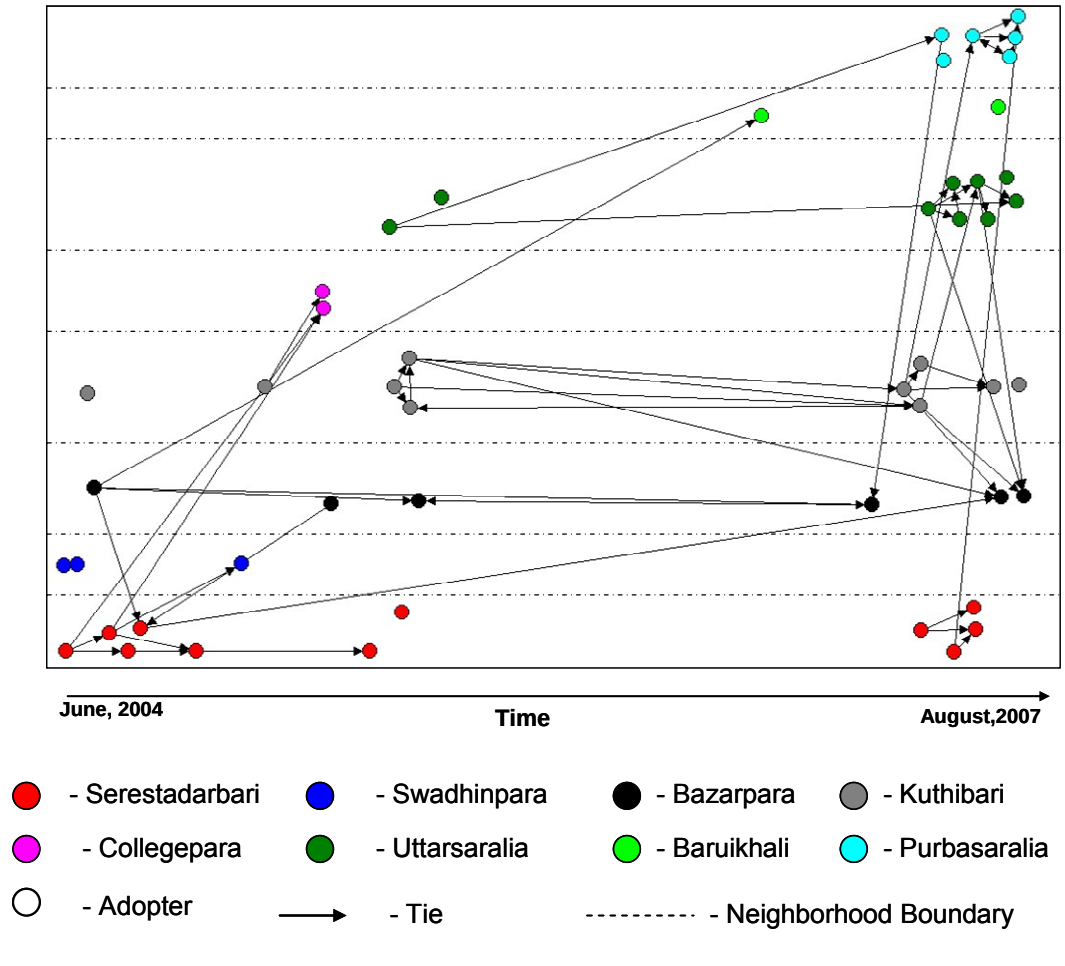
It is now instrumental to look in details how such above mentioned information sharing network patterns influenced the tank dissemination process in its different phases. The graphs (Fig. 4.11, 4.12 and 4.13) below show the relation between information flow through social networks in each phase of the adoption process and the spatial distribution of adopters. The major scenarios that has come forth in the above mentioned connection are as follows –

1) All the innovators or pioneers stand as alone in receiving information that depicts that all of them were informed by the NGO members and from the outside individuals. The pioneer is one who brings information from the outside of the community and may or may not diffusion the information among his community members.

2) The presence of hearing and discussion social ties among the adopters is noticeably concentrated or closed in the spatial distribution of adopters rather than the inter-neighborhood ties, except a very few cases. Unlike hearing networks, the social network of observation is not spatially closed. A higher numbers of inter-neighborhoods ties are observed. Therefore, tank in one neighborhood become a source of learning for the individuals of another neighborhood. However, adopters hearing and discussion partners are their own neighborhood.

3) Social networks of hearing and discussion show that the rate of adaptation is higher in those neighborhoods where the networks ties is dense, for example – 'Serestadarbari' and 'Kuthibari'. The presence and absence of observation networks did not influence the diffusion process. For example, in all neighborhoods, observation networks are present, but the rate of tank adoption varies among the neighborhoods.

Fig. 4.11 The Spatial distribution of social networks of hearing information flow (excluding NGO workers and outsiders) in relation to diffusion of rainwater tanks in Morrelganj town.



4) Social network of hearing and discussion shows, the rate of adoption in those neighborhoods are much higher where the pioneers after their adoption pass the information to their neighborhood members and a low rate of tank adoption observed in those neighborhood where early adopters adopted the tank in early phase of adoption but did not pass it to community members. For example, the two members of 'Swadhinpara' neighborhood adopted the rainwater tank in the early phase of diffusion process, but since the social network is absent in this cluster, it can be said that the pioneers did not pass the information, and there is no consequent adopter in this cluster. The same trend can be observed in case of 'Collegepara'. In a contrary, in Uttar-Sralia', where the adoption were started quite afterward in respect of the whole town's adoption, but since the early adopters of this community pass the information to its community members , the number of adopters in this zone is considerably higher. It depicts that

social networks of hearing and discussion render or provide the condition of diffusion of innovation process in positive way. Such connotation can not be found in case of observation network. Adopters of Swadhinpara, Collegepara neighborhoods observed the tanks of others, but the tank diffusion stopped after a certain period.

5) The temporal dimension of social networks of hearing along with the spatial dimension can also be found in the present study. Figure 4.11 shows that in case of neighborhood 'Serestadarbari', an early adopter, both in respect of 'system networks' and neighborhood networks relied on NGO workers or outsider for seeking information and once he/she adopted, information was passed to some other individuals who adopted the tank afterward. And then the newly adopter also passed the information to the next adopter and so on. But after a certain phase, the diffusion of innovation was stopped and also the social network became absent. In a second phase of adoption, there was only one adopter who has no connection with community members and adopted the tank by relying outside world and community to collect information. In the last phase of this diffusion, depending on the information of NGO workers, again an adopter initiated to adopt the tank and passed the information to his network partners which contributed positively the growth of adoption. Therefore, in each phases of diffusion, the first adopters depend on the outside world for information and then he passed out this information to his or her network partners. It may be concluded that social network may sustain until a certain period of time and again a new social network emerge in a community and this changing nature of social networks has strong influence in the process of diffusion of innovation as because we have found that the late adopters in the third phase of adoption of 'Serestadarbari' depended on the social network support of his/her immediately earlier adopters instead of adopters of fist phase, seemingly an innovators, of adoption process. This finding may also contribute in a way that to need to find out the degree of innovation of an adopter, i.e., the categorization of adopters, we may pay heed not only at the system's rate of adoption, but also at the personal networks which is some cases temporally and spatially significant.

In case of discussion generated network, temporal dimension of network is not that extent prominent, however, such instance can be found in case Kuthibari neighborhood which shows that up to certain time, the tank diffusion rate in this neighbor is very low as there is no discussion network and adoption rate increased after the information sharing started to develop among the among the adopters. In addition, the Fig. 4.13 shows that in each neighbors the rate of tank adoption is higher when the density of discussion network is high. For example, the last phase of Uttarsaralia, Purbasaralia, and Kuthibari.

Unlike social networks of hearing and discussion, the social ties of observation can be found between the early adopters and late adopters. The observation ties are not temporally close and such ties did not influence the adoption rate over the period of time.

6) The adoption process is dispersed or unsteady where the social network of hearing and observation are inadequate, like – 'Swadhinpara', 'Collegepara', 'Purbasaralia', 'Baharbiunia'. The adaptation rates are steady and balanced in those neighborhoods where there are prominent social network. The observation generated network , however, did not influence the adoption process in a similar fashion.

Fig. 4.12 The Spatial distribution of social networks of observation information flow (excluding NGO workers and outsiders) in relation to diffusion of rainwater tanks in Morrelganj town.

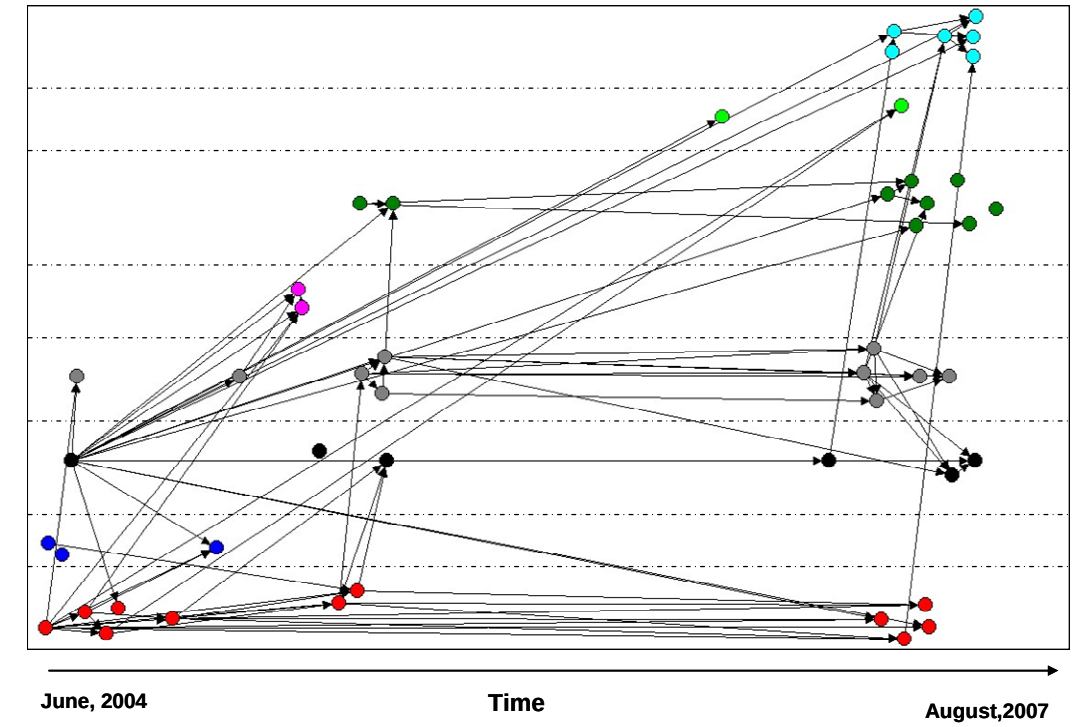
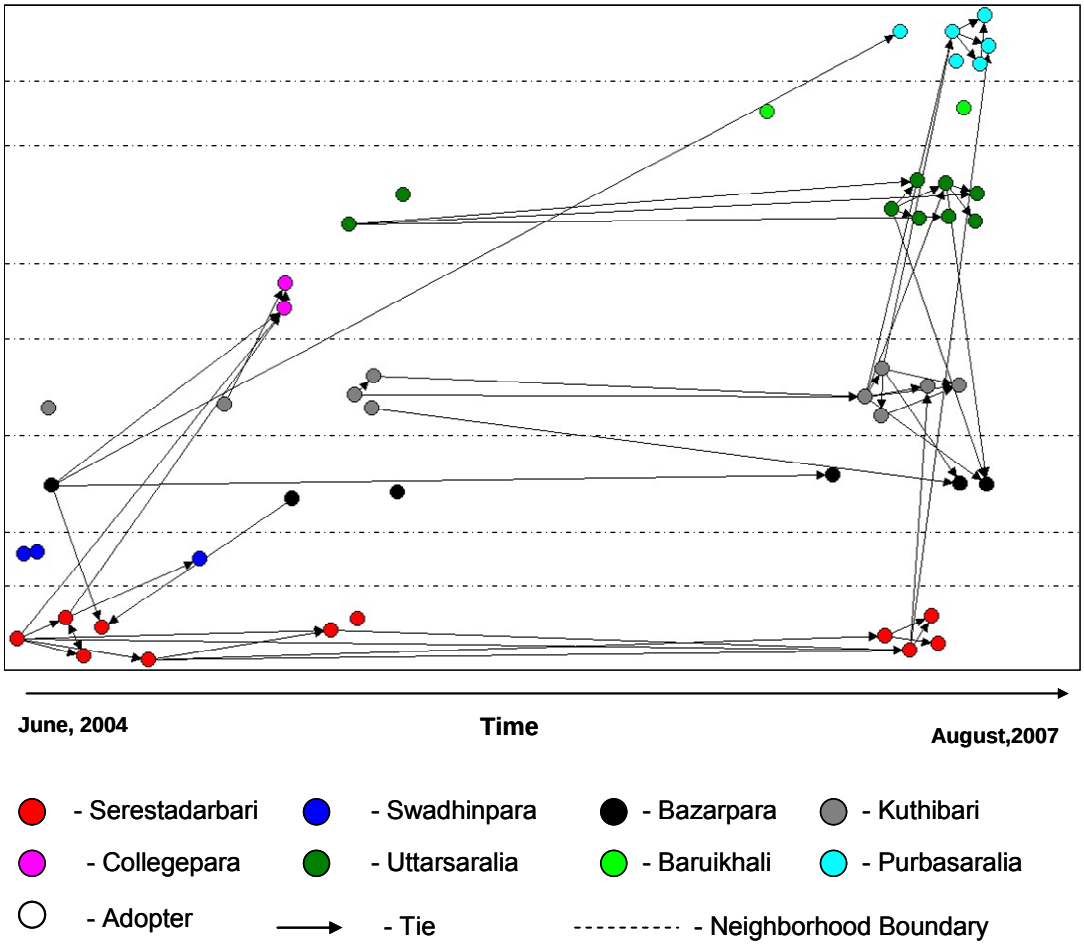


Fig. 4.13 The Spatial distribution of social networks of discussion information flow (excluding NGO workers and outsiders) in relation to diffusion of rainwater tanks in Morrelganj town.



Above discussion indicates that in the tank dissemination process in Morrelganj town is significantly influenced by the social networks of hearing and discussion, rather than observation. It also indicates that social networks of hearing are strongly associated with the social networks of discussion; on the contrary social networks of observation have developed in a different manner. The findings of Table 4.6 support such generalization. It shows that there is a stronger correlation between hearing and discussion generated networks, than observation and discussion networks. Therefore, the adopters may have observe various others tanks but it may not motivate them to adopt the tank , rather hearing from the community member positively influenced the adopters, and as a result hearing network partners often turned as discussion partners of the adopters.

Table 4. 6 QAP correlation score of Social networks of hearing, observation and discussion in Morrelganj Town

	Hearing and Observation	Hearing and Discussion	Observation and Discussion
QAP Correlation	0.48	0.68	0.54
QAP P-values	0	0	0

Chetalmari Upazila

Similar trend has been observed in the rural areas of Chetalmari Upazila, i.e, adopters mainly learned about the tank from the NGO workers (see Fig. 4.14 and 4.15), but in observation and discussion generated network, the involvement of the community members increased (See Fig 4.14, 4.15, 4.16, and 4.17). In comparison to Morrelganj town, the involvement of community members in hearing generated networks at Chetalmari Upazila (Fig. 4.15) is significantly low. Since a village settlement is comprised by a selected number of households, once the awareness campaign has been carried out by the NGO, almost all the individuals of a village came to know about the innovation or tank. However, the advantages and disadvantages of the tank are unknown to the individuals unless and until they observe the tank or discuss with co-villagers who have already adopted it. Because of this, table 4.7 as well as Fig. 4.17 and 4.19 shows that density of social networks of observation as well as social networks of discussion is significantly high. It indicates that adopters after hearing from the NGO workers preferred to observe the tank and discussed with the early adopters to make a prudent adoption decision. Therefore, adopters may be well informed about general aspects of the tanks, but observing others tank and discussing with others may have ensured their adoption decision. But social networks of observation and discussion are highly centralized as shown in Table 4.7. Thus, a few individuals played the role of

Fig.4.14 Network map of Hearing in Chetalmari (Including NGO workers and outsiders)

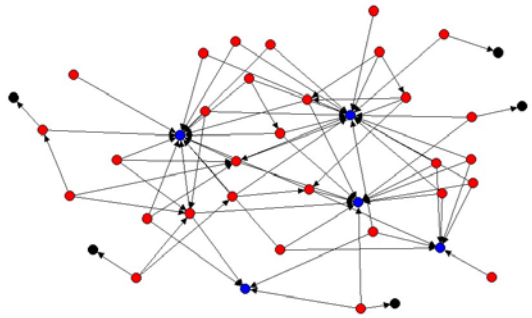
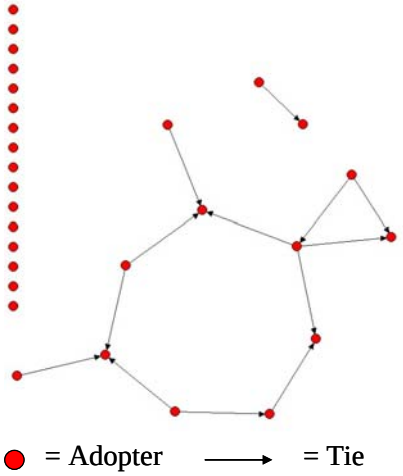


Fig. 4.15 Network map of Hearing in Chetalmari (Excluding NGO workers and outsiders)



discussion partners, and tanks which are situated in certain point may become sources of observation for many individuals. Importantly, a couple of individuals stand as isolated in both these networks, who may not discuss with anyone or may not observe any tank prior to their tank adoption.

Fig. 4.16 Network map of Observation in Chetalmari (Including NGO workers and outsiders)

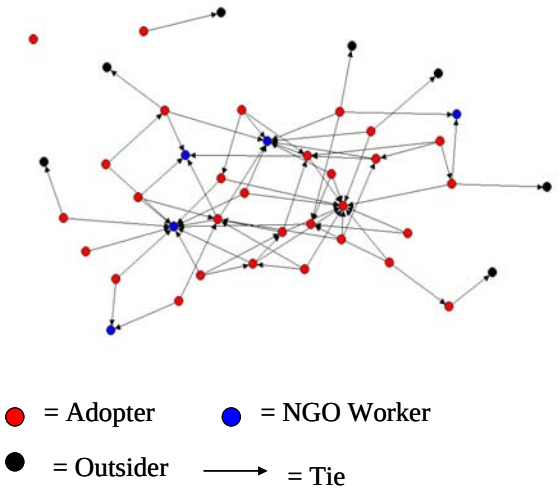


Fig. 4.17 Network map of Observation in Chetalmari (excluding NGO workers and outsiders)

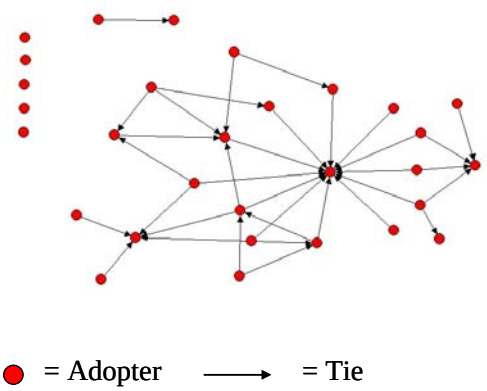


Fig. 4.18 Network map of Discussion in Chetalmari (Including NGO workers and outsiders)

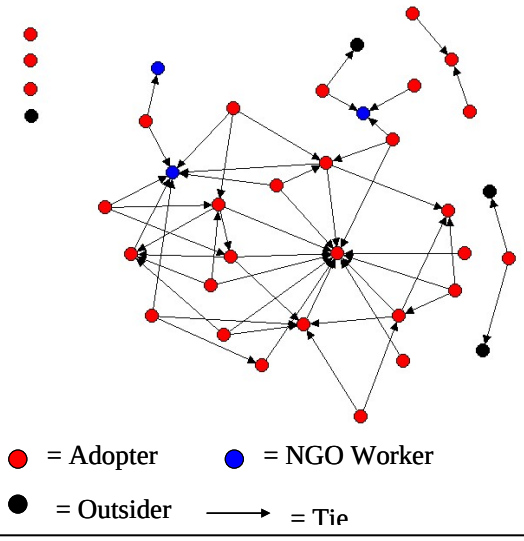


Fig. 4.19 Network map of Discussion in Chetalmari (Including NGO workers and outsiders)

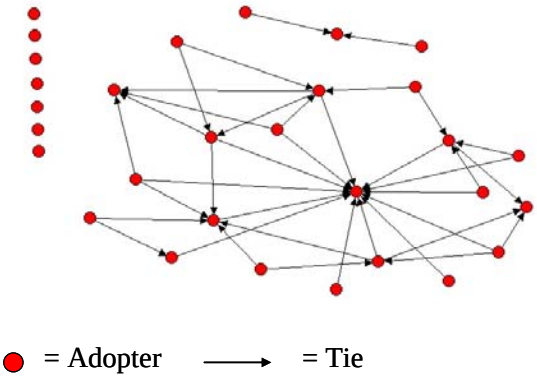


Table – 4.7 Network Density and Centralization Trends of Different Information Sharing Activities in Chetalmari Upazila (Excluding NGO workers and outsiders of the adopters)

	Hearing	Observation	Discussion
Network Density	0.018	0.040	0.043
Network Centralization	12.36	38.64	41.85

** p<0.01, *p<0.05

Comparing with Morrelganj town, an opposite trend has been found in Chetalmari rural areas. Table 4.8 shows that there is no association between neighborhood level of innovativeness and outgoing degree centrality of hearing. The neighborhood level innovativeness and outgoing degree centrality of observation and discussion are moderately correlated. Thus not all the neighborhood innovators pass the information to other individuals. Whereas, the system level innovativeness are strongly correlated with all kinds of degree centrality including hearing, observation and discussion. Therefore those who adopted early in the whole region passed the information other individuals irrespective of village or geographical boundary. As a result, Table 4.9 shows that all degree centrality of early adopters are higher than other adopters, whereas very low threshold adopters and low threshold adopters of late majority phase received a very low degree centrality score. Overall, those who adopted at the earliest, very low threshold adopter of early adopter stage received the highest score.

Table – 4.8 Correlation between Information sharing (out-degree centrality) and degree of innovativeness, Chetalmari

Level of Innovativeness	**Hearing**	**Observation**	**Discussion**
System/ Regional level	.68**	.61*	.63*
Neighborhood/ Village Level	.33	.38*	.39*

** p<0.01, *p<0.05

Table – 4.9 Table – 4.4 Out-degree centrality score of all the adopters in various information sharing networks in Chetalmari Upazila

System Networks	**Neighborhood Network**				**System Total**
	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters					
Hearing	1.5	2	-	-	1.75
Observation	4.5	2.5	-	-	3.5
Discussion	4.75	3	-	-	3.87
Early Majority					
Hearing	-	0	-	-	0
Observation	-	0	-	-	0
Discussion	-	0	-	-	0
Late Majority					
Hearing	0	1	.12	0	.095
Observation	.25	2	.50	0	.33
Discussion	0	2	.62	0	.33
Laggard					
Hearing	-	-	-	-	-
Observation	-	-	-	-	-
Discussion	-	-	-	-	-
Neighborhood Network Total					
Hearing	.75	1.50	.12	0	
Observation	2.37	2	.50	0	
Discussion	2.37	2.33	.63	0	

Table 4.10 shows that average betweenness centrality is quite low. Thus there may be a low probability of indirect flow of information among the individuals; information may be restricted within closed circle. Not the innovators, but late adopters with low threshold are potential individuals of circulating information indirectly among the individuals.

Table – 4.10 Betweenness centrality score of all the adopters in various information sharing networks in Chetalmari Upazila

System Networks	**Neighborhood Network**				**System Total**
	Very Low Threshold	Low Threshold	High Threshold	Very High Threshold	
Early Adopters					
Hearing	0	0	-	-	0
Observation	0	.62	-	-	.31
Discussion	0	1.25	-	-	.62
Early Majority					
Hearing	-	0	-	-	0
Observation	-	0	-	-	0
Discussion	-	0	-	-	0
Late Majority					
Hearing	0	2	.12	0	.14
Observation	.12	5.50	.43	0	.45
Discussion	0	5	1.12	0	.67
Laggard					
Hearing	-	-	-	-	-
Observation	-	-	-	-	-
Discussion	-	-	-	-	-
Neighborhood Network Total					
Hearing	0	.33	.12	0	1
Observation	.06	1.33	.44	0	.40
Discussion	0	1.67	1.12	0	.63

The graphs below show the relation between information flow through social networks in each phase of the adoption process and also the spatial distribution of adopters. The major scenarios that has come forth in the above mentioned connection are as follows –

1) All types of information have been shared across the village boundary. In particular, social ties have been established between Khalishpur and Sahoshpur village, and adoption rate in those two villages is high. Social networks between two villages may help the adopters to get suggestion, advice about the tank from inside and outside their village. Similarly it may provide opportunity to observe the tank inside and outside their village. As mentioned in the above section that due to NGO's awareness campaign, the general knowledge of the tank is known to all the individuals in those respective villages. But observing tank within and outside the village and also discussing with the individuals who have already adopted may assure the late adopters to make assertive decision about the tank.

2) There are some isolated adopters who recently initited such water harvesting in their own respective village without receiving any information from adopters of other village, like Pachpara, Singa, Sarecarani Adoption rate in those villages are low. Mass media like TV, ne2wspaer or NGO workers may help them to get necessary information.

However, due to absence of social ties, in those villages such adoption is till an isolated action and could not turn into a general adoption trend of the village.

3) Unlike Morrelganj town, all types of social networks are not temporally closed. Also, the ties have been established between innovators and late adopters. In particular, the innovators of Khalishpur village took the main initiatives to flow information among the others including outside their own village, like Sahoshpur, Singa, Roygram. Thus, adopters of those two village not only enjoy to observe the tank of their own village but they observe the tank of neighboring village and it helps also early adopter of neighboring village to make adoption decision.

Fig. 4.20 The Spatial distribution of social networks of Hearing information flow (excluding NGO workers and outsiders) in relation to diffusion of rainwater tanks in Chetalmari Upazila.

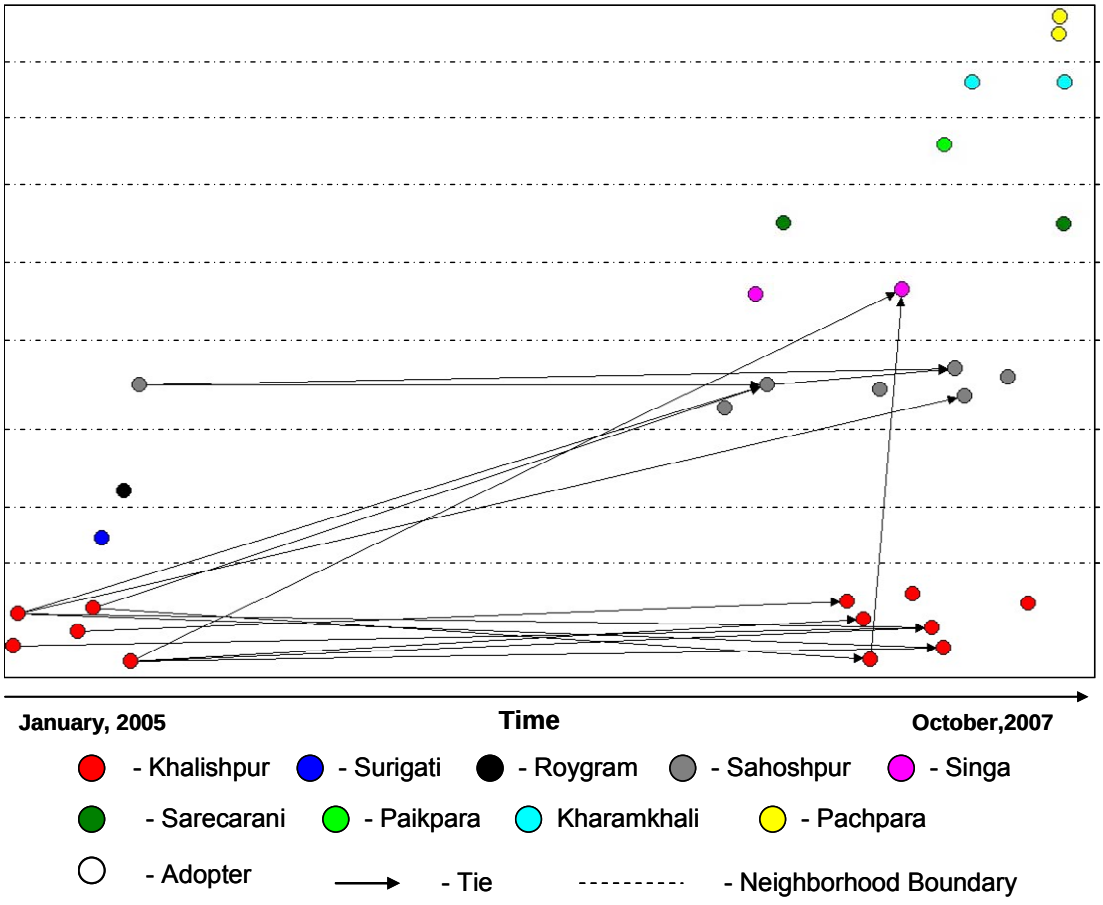


Fig. 4.21 The Spatial distribution of social networks of observation information flow (excluding NGO workers and outsiders) in relation to diffusion of rainwater tanks in Chetalmari Upazila.

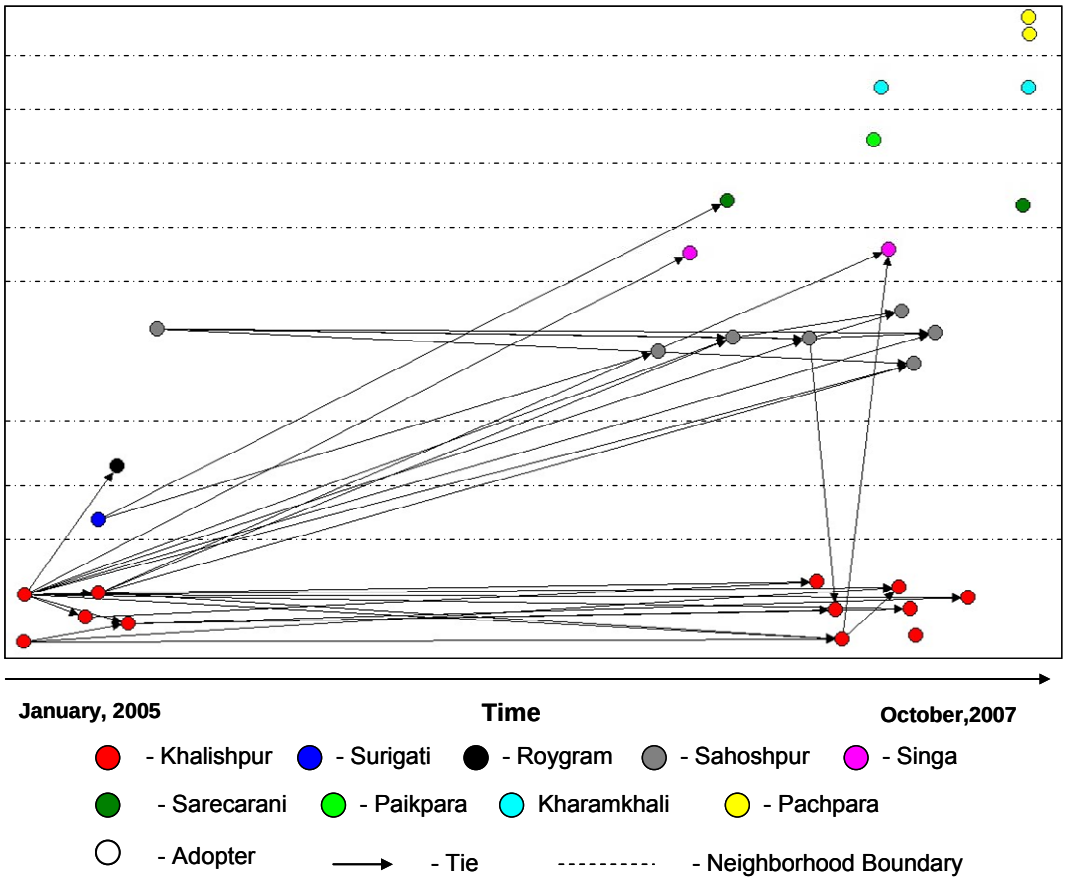
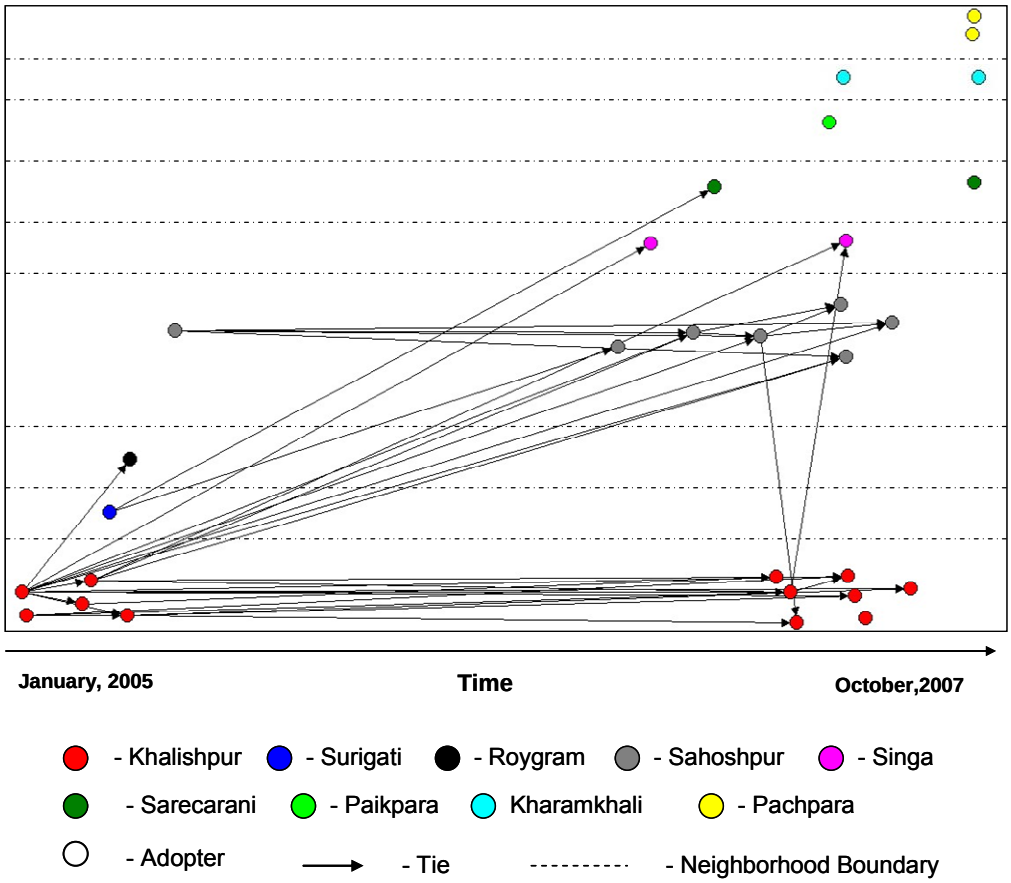


Fig. 4.22 The Spatial distribution of social networks of discussion information flow (excluding NGO workers and outsiders) in relation to diffusion of rainwater tanks in Chetalmari Upazila.



4.4.3 Social referents of information sharing

Above discussion shows social networks development process in the Morrelganj town took place in a more dynamic way than other two case study areas. Therefore, it seems that not only amount of information, but sources of information influenced the tank dissemination process in this town. Information acquisition from others is often constrained by the nature of relationship between a recipient and a donor of information (Shah, 1998). Therefore, it is necessary to examine from where the information has been received or who sent information to whom.

Table – 4.11 shows that that all types of information sharing activities took place outside the economic group. Thus, adopters received and forwarded all types of information more outside their occupational and income group than within the group. For example - those who are businessman received and forwarded information more with the individuals who are not involve in business sector. On the contrary, adopters shared all types of information more within their religious group. The Hindus preferred to share

information with the Hindus and the Muslims preferred to share information with the Muslims. Similarly, adopters shared all types of information more within their neighborhood than outside the neighborhood, however, the EI - Index score of neighborhood in case of observation is lower than hearing and discussion activities. It demonstrates that adopters strongly preferred hearing and discussing more within the neighborhood than the observation. Hearing and discussion information sharing activities also took place more within structural and cohesive group members, rather than outside the group, whereas, observation took place across the structural and cohesive group boundaries.

Table – 4.11 Sharing various information and degree of homogeneity (EI - Index) in Morrelganj Town

Group Criteria		Hearing	Observation	Discussion
Cultural Group	Religion	- 0.725	- 0.750	- 0.704
Economic Group	Income	0.333	0.364	0.333
	Occupation	0.294	0.432	0.184
Spatial Group	Neighborhood	- 0.294	- 0.114	- 0.333
Social Network Group	Cohesive	- 0.176	0.182	- 0.111
	Structurally Equivalent	- 0.294	0.114	- 0.259

QAP multiple regression analysis in Table 4.12 shows that that adopters heard about the rainwater mostly from the cohesive group members i.e., with whom the adopter having higher degree of interaction in day to day life. The Neighbor is also significant sources for hearing, whereas structural equivalent group is non-significant. Cultural and economic group partners did not play any significant role for hearing. Observation networks shows adopters observe the tank both from their neighbors and cohesive group partners, but still the neighbor is the greatest source of observation. Structural equivalence members became more insignificant in this case. Adopters also discussed more often with their cohesive group partner than any other group members. Neighbors are also significantly as discussion partners, but not the structural equivalent partners or their other demographic group members like income, occupational or religious group members.

Table – 4.12 Results of Regression analysis on social Referents for Hearing, Observation and Discussion in Morrelganj Town

Group Criteria		Hearing	Observation	Discussion
Cultural Group	Religion	.002	.020	.002
Economic Group	Income	.001	.000	- .001
	Occupation	.013	.012	.021
Spatial Group	Neighborhood	.048	.090	.061
Social Network Group	Cohesive	.080	.072	. 081
	Structurally Equivalent	.027	.001	.018
R- Square		**.084**	**.070**	**.080**

As mentioned in Chapter 3, the adopters of tanks are already an affluent or elite section of the town and therefore they are already segregated group of individuals from the mass. Within this already segregated group, there is not much economic difference and their economic background did not influence their social interaction patterns as well as tank related information sharing activities. A school teacher may not interact with a rickshaw-puller or a wage laborer in his/her daily life, but a school teacher often interact

with a college teach or business man in their daily life and this social interaction provides other information like information on rainwater tank.

Individuals having same religion share all types of information more within their religious group, but religious group partners are major social referents of information. Since in this locality, religion is one of the dominant means of social control, individuals prefer to share information more within the own religious group, but that does not mean that they did not receive any information from outside their religious group. An individual receives information from various sources, like from co-workers, co-political members, co-club members, neighbors who may or may not belong to his or her own religious group. Therefore, though the ties within the religious group are much higher, but an individual's social referent of information are those with whom he or she share stronger social interaction. Therefore, hearing and discussion networks are not only more within the cohesive group, but also cohesive group partners are most often chosen as social referents for hearing and discussion. A cohesive group is comprised by the individuals who have most intensive social relation irrespective of their cultural and economic background; therefore, higher degree of social interactions or social ties provides a platform for sharing different issues including information related to rainwater harvesting.

Observation is significantly related with geographical proximities. For example, a person can be informed about the tank by his friends or co-workers living in another villages or neighborhoods, but he can not observe the tank unless they live in same neighborhoods or visiting his/ her co-workers house. Similarly, individuals can observe the tank in a house with which he has no social interaction and acquaintance. For example, we found in lot of cases that they observed the rainwater tank in their neighborhood with whom they have no social interaction and therefore the individual did not discuss about the tank with his neighbors, but he preferred to discuss about his co-workers who has similar tank. In our study, we have found that that Fazlu Gaji, a tank adopter in Bazarpara neighborhood, whose tank became a source of observation for 18 other adopters, but only 4 individuals heard about the tank from Fazlu Gaji and only 2 individuals discussed with him prior to their tank adoption. Fazlu Gaji's house is located at Bazar or market place of the town. Such location of his house or tank, offers other to watch it and become informed about it whether or not knowing Fazlu Gaji.

An interesting finding is that neighbors are significantly adopter's social referents in all information seeking activities. The reason behind that a majority of the cases neighbors are adopter's cohesive group partners, or in other words, people interact most often with their neighbors in daily life irrespective of their religion, occupation and income. As we mentioned earlier that each of the neighborhood has own special characteristics and each of the neighborhood is comprised by a homogeneous group of individuals. Such socio-economic proximity strengthens their social interpersonal contacts and information sharing activities.

Structural equivalent groups are not found important social referents of information for the adopters. Since a structural equivalent group is comprised by the individuals having similar position in the structure, it creates or generates social competition (Burt, 1983) and individuals in a structurally equivalent group shares similar social environment. Competition or social environment did not influence the information sharing activities in Morrelganj town. Adopters may prefer to receive information or forward the information only to their closely tied individuals.

4.5 Summary

1) There is almost no role of mass media in tank dissemination process in both rural and urban areas of areas of Morrelganj Upazila, whereas mass media may have a moderate role in the early phase of the tank diffusion process in Chetalmari Upazila.

2) In the rural areas of both Upazilas (sub-districts) adopters have heard about the rainwater mainly from the NGO workers. As the awareness campaign has been carried out by the NGO in those regions, all the individuals including the adopters and non-adopters in those selective villages came to know about the tank from the NGO adopter. Awareness campaign provided a general idea of the tank to all section of individuals in those areas. Thus general information about the tank was available to almost all the individuals in those villages. As a result, social network of hearing among the community members in the rural areas of both these Upazilas (sub-district) is not dense. Since, a village consists of selected number of households; it may have been possible for the NGO worker to disseminate the information among all the households in those villages. However, knowing from NGO worker did not motivate all the villagers to install it, rather only a few groups of individuals have adopted the tank. This group of individuals neither has observed the tank, nor do they have discussed with other who have installed the tank. However, they took the risks and adopted the tank. In the next phase, observing their tanks and discussing with the early adopters, another group of individuals become certain about the effectiveness of the tank and become motivated to install it. As a result, social networks of observation and discussion are quite highly dense in those regions. However, in case of rural areas of Morrelganj Upazila, since the NGO pull out the programme, the further dissemination has not taken place in the same villages. But in case of rural areas of Chetalmari Upazila, sharing information, particularly social networks of discussion, induced the tank dissemination. Individuals may preferred to know the first-hand experience of the users in order to relate the effectiveness of the tank with their personal needs and requirements, and as a result the density of social networks of discussion is quite higher than the density of social network of hearing among the community members. Villages which are physically closely located, social networks have established among the members of those villages. It helped the members of one village to observe the tanks of other village and also discuss with individuals who have already adopted it. Physical proximity induced social contagion. Since the individuals did not need to depend on the own village members for discussion and observation, those who are innovators in respect of the whole region played the major role in information diffusion. As a result, the early adopters received higher outgoing centrality score of information sharing activities. The tank adoption rate is high in those villages which are well connected with other villages where the tank has already been installed. Results showed that social networks are not spatially closed, and social networks of discussion played the major role in tank dissemination process. However, the villages which are located at greater distance from these villages, social network have not been established with those villages. The individuals in those villages learned about the tank from NGO workers. Due to their physically barrier, the members of those villages are unable to discuss with the members of other villages where the tank has been installed. As a result, though knowing from mass media or NGO workers, a very few individuals in those village have adopted the tank; the tank adoption rate is still very low.

3) A different scenario is found in case of urban area, Morrelganj town. Since an urban settlement is comprised by a higher number of individuals or households, the NGO could not reach to all the individuals of the town to inform about the tank. As a result, apart from the NGO workers' campaign, the information of tank has also diffused through the community members from mouth to mouth. As a result, not only observation and discussion, but also social network of hearing is quite dense in Morrelganj town. Information was not passed by all of the innovators in respect of the whole region; but the individuals may have received information from their respective neighborhoods' innovators. It is also found that in the initial phase, a group of innovators directly informed to the selected number of individuals and afterward through the initiative of late adopters, information disseminated indirectly between the adopters at a wider scale. Adopters heard and discussed about the tank from the neighborhood level innovators, but they observe the tanks of system level adopters who installed the tank in very early phase of the dissemination. The presence of hearing and discussion social ties among the adopters is noticeably concentrated or closed in the spatial distribution of adopters rather than the inter-neighborhood ties, except a very few cases. Unlike hearing networks, the social network of observation is not spatially closed. Social networks of hearing and discussion influenced the dissemination process in a significant manner, which is not found in case of observation. For example, Social networks of hearing and discussion show that the rate of adaptation is higher in those neighborhoods where the network is dens. But the presence and absence of observation networks did not influence the diffusion process. Social network of hearing and discussion shows, the rate of adoption in those neighborhoods are much higher where the pioneers after their adoption pass the information to their neighborhood members and a low rate of tank adoption observed in those neighborhood where early adopters adopted the tank in early phase of adoption but did not pass it to community members. Such connotation can not be found in case of observation network. The temporal dimension of social networks of hearing along with the spatial dimension can also be found in the present study. The result shows that social networks do exist for certain period of time, and afterward again new social network emerged, particularly in case of hearing and discussion.

In Morrelganj town, since the adopters are economically affluent section of the locality, information sharing activities are not closed within the economic group rather information has been shared across the occupational and income groups. However, adopter hearing and discussion networks are more closed within their cultural, spatial and social network groups. Individuals heard about the tank mostly from their cohesive group members and also a same trend has been found in case of discussion. So higher the informal network among the adopters, it encouraged their information sharing activities irrespective of their occupation, religion, income and neighborhood. Since a majority of the cases, individuals' cohesive group partners are their neighbors, neighborhood members also have a significant role with hearing and discussion types of information sharing activity. Individuals observed the tank mostly from their neighborhood partners. Therefore, a correlation has been found between observation and geographical location.

Innovative technology dissemination in the above mention regions took place through an already designed and established organizational structure. "People for Rainwater", the NPO from Japan, already arranged finical and technical support; their first hand experience in other regions also helped the local implementing agency to design the

programme in order to implement the tank. The challenge for the local NGO or implementing agency was therefore to bring the technology to end users by utilizing the already existing organizational set up. Therefore, it was instrumental to understand and examine the pattern, nature and direction of social networks exist among them adopter, which may foster the dissemination process. The relation or networks among the end users or adopteras has appeared as a crucial component in order to diffuse the technology at a wider scale. However, the area where such organization set up does not exist; it could be itself a challenge to develop such organizational structure in order to operationalize the implementation process. Addressing the issue, the next chapter attempts to show how the network development among the players of an organization helps to cultivate the fruits of an invention.

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Chapter 5 - Modeling and Analysis of Social Implementation Process of Rainwater Harvesting Technology in Sumida City, Japan

5.1 Introduction

This chapter deals with rainwater harvesting movement in the Sumida Ward, Tokyo. In the first section of this chapter, the network formation among various key players of rainwater harvesting movement has been described. Based on Social network model developed by Okada and Kobayashi (1989), later modified by Okada (1993), it was attempted to shows how the collaboration and interaction among the players helps to bring the innovative rainwater harvesting technology to the end users. It also shows why and how network among the players are important in order to diffuse the innovation from one region to another. The later section of the chapters focused on the nature and pattern of information sharing activities among the adopters or tank users. It shows the bottlenecks of the implementation of the rainwater harvesting technology at a wider scale in order to meet the micro level requirements of the adopters in Sumida Ward, Tokyo.

5.2 Problem Description

5.2.1 Disaster risks in the Sumida Ward, Tokyo

Sumida Ward (Sumida-ku) is located in the eastern part of Tokyo. It has a population of 225,935 persons as of December, 2001 (Samaddar and Okada, 2007).Being a part of the Tokyo (Metropolitan) City, the Sumida Ward is confronted by various disaster and environmental risks in the course of urbanization. The major disaster risks that have been faced by the Sumida city are as follows:

Situation – 1 (Water Scarcity): Water supply in the Tokyo City largely depends on constructing dams in the upstream region of the Tone and Tame Rivers. Until quite recently the numbers of dams have increased to meet up the continuously-growing water requirements of Tokyo population. But the shade of resorting to this commonly used countermeasure by utilizing a huge amount of money and manpower, instead of securing adequate water for the city was that it forced displacement of people and devastation of vast areas of farmland in the upstream region (Group Raindrops, 1995). Moreover, the dams have gradually been loosing water storage capacity due to continuous silt deposition. Thus, the process will ultimately bring regional imbalance and environmental insecurity among the communities of the city, even if, the city of Tokyo and its surrounding regions still need adequate water to sustain.

Situation – 2 (Flood): The city has more than two billion cub.ic meters of rainfall every year. Rainwater is directed to the sewage system and released into rivers. Consequently, the flow exceeds the river system, resulting in floods. Floods challenge this modern mega-city and may paralyze the efficient transport system, safe drinking water, performing daily activities etc (Samaddar and Okada, 2007; Group Raindrop, 1995).

Situation –3 (Water and environmental contamination): Since the vast lands of the city area have been covered by asphalt, it is a reason of hindrance for groundwater recharging. In 70's when Japan was enjoying unprecedented economic growth, factories and buildings pumped up groundwater from deep wells excessively disregarding nature's water circulation. Consequently, shallow wells dried up resulting in subsidence, for example- part of Sumida Ward sank by 3.5m at the deepest.

5.2.2 Rainwater Harvesting Initiative and Its Dissemination Process

Addressing the water related risks in Sumida city, Murase, a sanitary officer in the 'Sumida City Office' came up with an innovative idea i.e., the practice of rainwater harvesting. His idea is that that instead of discharging the rainwater into the sewage, rain can be caught where it drops and thus collecting rainwater and recycling it may be a possible answer of Sumida's water risks. The idea of "Mini dam" was introduced by him in order to tapped rainwater at household and community level. He claimed that the stored water can be used as flashing toilets, drinking water in emergency and also for other domestic purpose like cleaning, washing, and gardening.

His idea was not immediately accepted by the others players including the local community members. Afterward, a group of progressive individuals, majority of them are the inhabitants of the Sumida ward, recognized the importance and value of this innovative idea and came up to encourage and implement the idea. They formed an informal organization call "Raindrop Group" under the leadership of Murase. Initially, the group started to documenting and studying the rainwater harvesting practices and researches around the world in order to develop a technology applicable in their local situation.

In 1982, when the construction of "Sumo National Stadium" was planed at Sumida city, this group of individuals under the leadership of Murase through the "Sumida City office" proposed the "Sumo Association" to introduce rainwater harvesting in the Sumo stadium. The idea was to collect rainwater through the large roof of the Sumo stadium and use it for flashing toilets and other non-drinking purposes. Murase claimed advocated that this technology not only help reducing pressure on the city's sewage system and preventing floods in the locality, but Sumo Association can also reduce their water utility cost as well as an effective management of natural resources can be done. Initially the idea was rejected by the Sumo association. Murase then realized the need of political and administrative intervention for implementing such technology. Being a staff of Sumida city Office, he took the opportunity to demonstrate the technology in front of the mayor of the Sumida city and requested him the law enforcement for the implementation of such noble idea in the upcoming Sumo National Stadium. Appreciating Murase's innovative idea, the Mayor through the Tokyo Metropolitan Authority asked the "Sumo association" to pursue the proposal as an obligation. Though rejected initially, the "Sumo association" started to get the results of the innovative technology immediately after the implementation (Group Raindrop, 1995; Murase, Prospect of Rainwater Utilization in the 21st Century)

Due to the successful implementation of technology at the "Sumo National Stadium", Dr. Murase and his group received enormous media attention inside and outside the Japan. As a result the technology got recognized by the local government and also by the local community as a potential means for fighting with present and future water related risks. Moreover, the information about the rainwater harvesting technology disseminated at a large scales population through the mass media.

The initial success encouraged and motivated Dr. Murase and his group to design and modify the technology to be more locally applicable. In 1989, they came up with their proposal of the "Sumida Oasis Concept" and submitted it to the city authorities as a suggestion for the effective water resource management (Group Raindrop, 1995). The concept includes the rejuvenation of the dried up water ways in the Sumida City through supplying rainwater collected from the roof to the streams, setting up 'Rojison', a

community level rainwater harvesting system, and also rainwater harvesting at household level in a small drum. However, the concept failed to be realized by the local government initially.

In the due course, the “Raindrop group” built informal networks with various specialists and professionals like architects, engineers, plumbers, and academician. Networking with the professionals helped the group to modify their technology as well spread the idea and the movement at wider level. The spread of networks strengthen the ground to implement the rainwater harvesting technology in other public and private buildings.

After a short gap, Sumida City office introduced the technology in the building of Sumida City Office. Murase and his group then took initiative to implement the idea of Rojison, a small-scale community level water harvesting. ‘Roji’ means street and ‘Son’ corresponds to “Respect” in Japanese language, thus it means the object of roadside respect. Rainwater collected from the roofs of the nearby houses is stored in an underground tank in the public place like at roadside, small parks. The stored water can be pumped up with a hand pump. “Rojison” as a physical object has served as a symbol of encouraging community level water harvesting practice. It is also a symbol of neighborhood safety and protection. Above all, ‘Rojison’ serves a as public place where the community members can share their ideas, problems and interests. To encourage such movement, Sumida City office started to sponsor the programme. Rainwater harvesting at household level in a small tank was also designed and planed to implement the technology at more micro level. “Raindrop Group” started to develop various models of rainwater tank for single households.

In 1994, Tokyo International Rainwater Utilization Conference (TIRUC) was held on the theme of “Rainwater Utilization Saves the Earth - form a friendship with raindrops in urban areas -" in Sumida City. TIRUC Organizing committee was organized by the initiatives of citizens and the cooperation of Sumida City Office. Various national and international organization who are interested and practicing rainwater harvesting technology participated in the conference to share their ideas. Dr. Murase took the initiatives in success of TIRUC as secretary general of TIRUC Organizing committee. This ultimately helped to build up network with various national and international organizations in order to promote the technology (Shimbun, 2003; Japan for Sustainability, 2003).

After TIRUC, the TIRUC Organizing Committee installed 100 rainwater tanks in Kobe City where water supply systems were cut off for one month by the Great Hanshin Earthquake in 1995. These tanks stocked drinking water from emergency water tank till the recovery of the city water supply systems and collected rainwater for use by Kobe residents. After this urgent project, Murase and his group renamed their group and registered their organization as a NPO. The organization became named as “People for Rainwater” (PR). More professional, academicians joined hands with them and involved with the movement and as a result the movement literally started to diffuse across the regions.

In response to this, in March 1995, Sumida City Office decided to implement “Rainwater Utilization Promotion Guidelines”. The outlines of the guideline included - First, in the future construction of city facilities, rainwater utilization systems should be installed. Second, for a fixed scale development (over 500 m^2) , the developer should be directed and encouraged to use rainwater. Third, rainwater tank facilities for citizens should be

subsidized. In the same year from October, the subsidization of rainwater tanks for citizens began. Thus far, 190 rainwater tanks have received subsidies and are set up. 19 Rojison facilities have been installed in Sumida City. Sumida City Office enforced law for all new public building in Sumida Ward to introduce rainwater tanks and also subsidy has been provided in order to implement the technology (Japan for Sustainability, 2003).

Sumida City has also undertaken a number of activities to share this example both with local governments in Japan and in other parts of the world. For example, in 1997 Sumida organized the "Liaison Council of Local Governments for Rainwater Utilization" to share experiences and exchange policy information in Japan. 116 local governments join this organization. At present 31 local governments in Japan took initiative of rainwater harvesting and provide subsidy for it. In March 2000, Japanese rainwater businesses association was established to cooperate with citizens and administrations to promote rainwater utilization based society. With the cooperation of PR (NPO), Sumida City was able to create a Rainwater Museum which opened on May14, 2001. Various types of rainwater tanks, rainwater collection systems and photos of rainwater utilization and rain culture all around the world are displayed in this museum through cooperation of NPOs in various different countries, governments, researchers and businesses connected with rainwater utilization. PR published Rain Encyclopedia written by Japanese on December 2002. It covers not only rainwater utilization but also rain culture, rain and creature, rain and climate, rain and Japanese. At present this has been translated and published into various languages in order to disseminate the information of rainwater harvesting technology across the countries. In addition, by receiving financial support from the Japanese Government, "People for Rainwater" took direct initiative to introduce similar rainwater harvesting technology in Bangladesh and other countries.

5.3 Methods

The study is based on primary and secondary data. In order to understand the organization structure and network development process which helps the implementation of rainwater harvesting technology, this study focus on the "Network Model of Organization" developed by Okada (1993) as mention in chapter 2. To test the model, data has been collected from secondary sources like reports, documents available in internets, journals etc. In addition, data have been collected by taking interviews of the community larders, NPO members, and governmental officials.

To understand the social networks among the adopters in Sumida City, field surveys have been conducted among 31 tank adopters in March, 2008. Structure and semi-structure face-to-face interviews have been conducted. Data have been collected on socioeconomic characteristics of the adopters, housing characteristics, satisfaction level, advantages and disadvantages of the tank. Apart from that, special focus has been given on social networks of information sharing. To identify and map the social networks of information seeking activities; three types of socio-metric data were collected. Dividing the information seeking activities into two parts , respondents were asked to answer two survey questions – a) for social networks of hearing - "Kindly name us three persons from whom you first time heard about the rainwater tank"; b) for social networks of observation – " Can you remember where you first time observed the rainwater tank?
To know the role of adopters in passing the information to others, the question has been asked – "Did you pass the information about the tank to anyone? If yes, kindly name us

the individuals whom you have passed the information". To map the interpersonal contact among the adopters in day to day life, the data has been collected by asking the adopters to name three tank adopters in their city to whom they often turn for advice and suggestion in daily life. Matrixes were formed for each types of social networks in such a way that cell entry Xij equaled one if actor i selected actor j for particular interaction. For example, if actor i heard about the tank from actor j, the cell entries equaled one, and all other entries equaled zero.

5.4 Results

5.4.1 Social Networks Development of Key Players

Given the above descried context, Table – 5.1 identifies the key players of rainwater harvesting technology dissemination process in Sumida according to the "Network Model of Organization" (Okada, 1993).

Table 5.1 List of Players in Sumida rainwater harvesting technology dissemination process

Innovators (I)	Dr. Murase
Comrades (C)	NPO (The members of " Raindrop Group" , later renamed and registered as " People for Rainwater" (PR))
Appreciator 1 (A1) Appreciators 2 (A2)	Local Government, Sumida City Office Professionals Communities (Engineers, architects, planners)
Director (D)	Local Government, Sumida City Office
Technical Supporter 1 (T1) Technical Supporter 2 (T2)	NPO ("People for Rainwater" Anonymous (Private companies)
Circulator 1 (C1) Circulator 2 (C2)	Mass Media Anonymous
Financier (F)	Local Government, Sumida City Office (Partially)
User 1 (U) User 2 (U2) User 3 (U3)	Owners of Public and private Buildings (Example – Sumo Association) Local Community (Example – users of Rojison) Owner of tanks at household level
Imitators 1 (IM 1) Imitators 2 (IM2)	Other local Governments in Japan The Institutions and organizations practicing rainwater harvesting tank outside Japan

Table 5.2 Matrix representing the phase of participation of players in innovation, Sumida City

	Pre-Invention	Pre-adoption								Post-Adoption		
Players	Embryogeny	Invention	Awareness	Interest	Study	Trails	Adoption	Adaption	Implementation	Diffusion	Obsolescence	Decay
Innovators (I)	*	*	*	*	*	*	*	*	*	*		
Comrades (C)			*	*	*	*	*	*	*	*		
Appreciator 1 (A1)				*		*	*	*	*	*		
Appreciators 2 (A2)								**	**	**		
Director (D)						*	*	*	*	*		
Technical Supporter 1 (T1)								*	*	*		
Technical Supporter 2 (T2)									**	**		
Circulator 1 (C1)							**	**	**	**		
Circulator 2 (C2)								**	**	**		
Financier (F)								*	*	*		
User 1 (U)						*	*	*	*	*		
User 2 (U2)								*	*	*		
User 3 (U3)								*	*	*		
Imitators 1 (IM 1)								**	**	**		
Imitators 2 (IM2)									**	**		

* indicates that the corresponding players enters in this phase

** indicates that the player belongs outside the region

Fig. 5.1 Social network development among the players in innovation dissemination, Sumida City

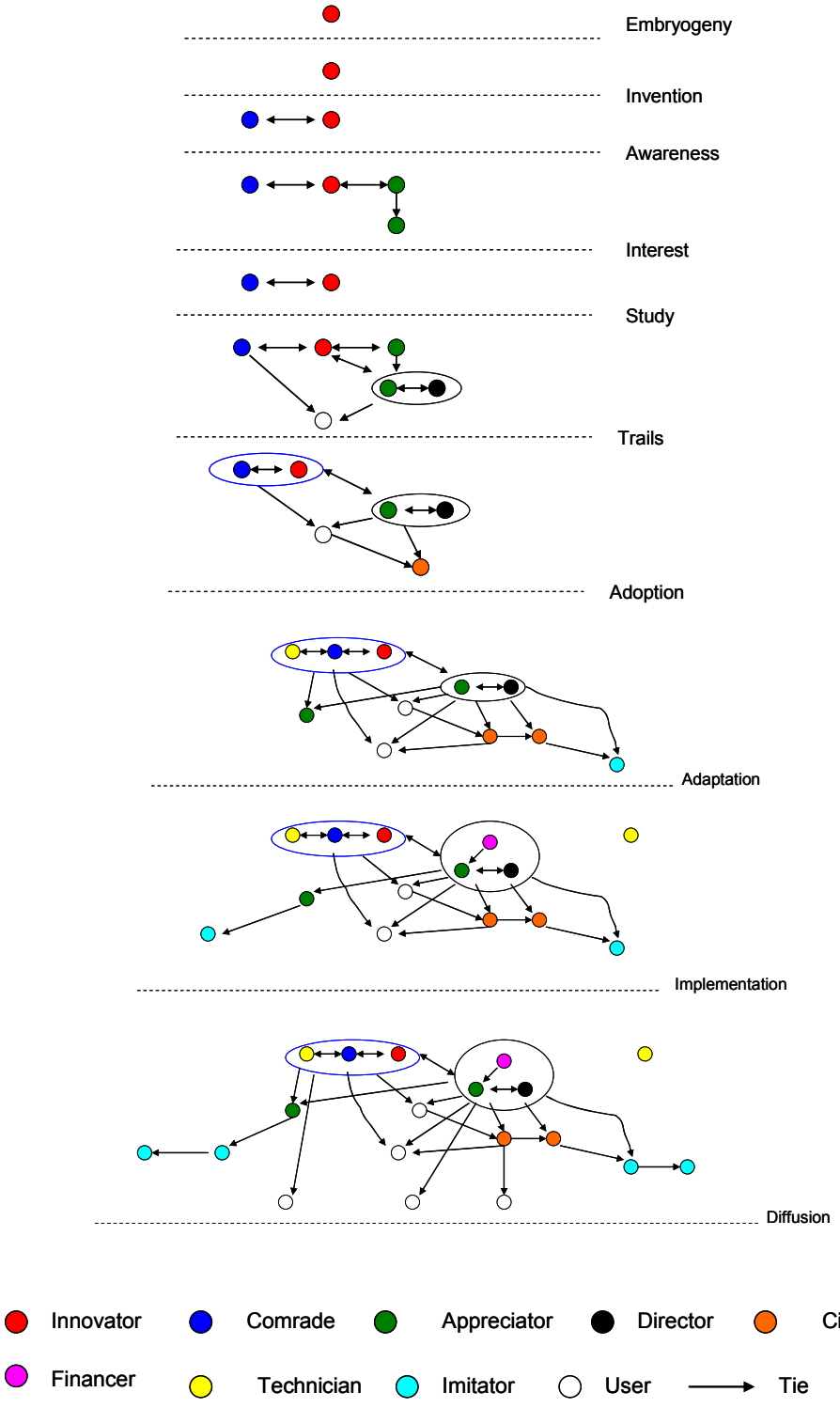


Table 5.2 shows the participation of players in various phases of technology dissemination. Fig 5.1 shows the networks development between the players in various phases of dissemination. Structuring the context into above mentioned tables and figures, the following points can be drawn

1) Apart from the Inventors or initiators, there are three players who played a crucial role in the dissemination process. They are appreciator, comrades and circulators. The role of these three players in different phases of the diffusion played significant changes in the dissemination process.

2) Once the technology was invented, it may not be appreciated and implemented if the comrades or a group of individuals did not recognize the importance of the technology. Fig. 5.1 shows that in the awareness phase, comrade ("Raindrop Group") came into the scenario and network has been built with the inventors. Due to the support of the comrades, the inventor did not stand alone. The support of the comrades may help to create a ground, so that the technology is appreciated by someone, Sumida City Office.

3) The challenge was therefore to test the technology. As mentioned in the earlier section that the technology was refused by the user initially. So the trail of the technology became possible by the presence of applicator who enjoyed enactment of law. Therefore, a trail becomes possible due to the network development among three players – inventors, comrades and appreciator. The absence of such network not only helped to trail the technology, but also helped to create a ground for the further dissemination of the technology as we know that after the successful implementation of the technology at Sumo stadium, the technology disseminated at different scales and levels. Thus, the region would have deprived from the fruits of such innovative technology without the network development between various local level players.

4) A significant characteristics of this technology dissemination process is that the technology started to disseminate across the region in the very early phase. This may become possible due to the role of circulator. Circulators played two important roles in this game – first, after the first trail of the technology, the circulator provided social support to the inventors and comrades to test this technology further. Since the message of successful implementation of the technology in Sumida stadium was circulated through the mass media, the director or Sumida City office realize the importance of the technology and become motivated to implement at wider scale. The circulators thus strengthen the local networks among appreciators, comrades and innovator. Second, through the initiative of circulator the message was circulated not only inside the region but also outside the region. As a result the innovation was appreciated by other players outside the region. Thus in one hand it helps the inventor and comrades to receive technical and other support outside the region. More professionals like engineers, architects, plumbers, social workers appreciated the technology and joined hand with the inventors and comrades. It helped to enrich and upgrade the technology to make it become more applicable. Finical support was provided by the Sumida city office by realizing the importance of the tank. Technology was started to implement at various scales, like household level, community level. Similarly, the other region became enriched with the technology and started to trail the technology. As a result, circulator worked as broker who established networks between various players inside and outside the region. Without the presence of circulator, the dissemination of the technology would have stopped after a certain period.

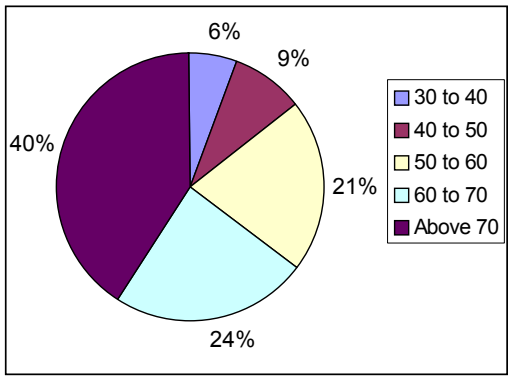
5) Another important trend that has found in this game is that after a certain phase of development, several different players merged into one group or in others words they started to operate under the same umbrella. For example, the investors, comrades and technicians they formed a group or platform from where various roles have been played. In one hand it helped to perform the roles in more organized way, but on the other hand, it may hamper to emerge new ideas or support which can be more functional in order to disseminate the tank. Suppose, if there are lot of technicians are there, it will help the end users to get various models of the technology. Competition between the technicians will enrich the design, price of the tank. The technology may be more easily available to the end users. Similarly, since Sumida City Office has been performing the role of financier, director and appreciator, the organization is bit centralized which may affect the future development of the dissemination.

The above discussion shows how the network development among the players at intra and inter regional level helped to bring the invention from the inventor to the end users. But to implement the tank at more macroscopic level, network development among the users is also important. Message circulation or dissemination through mouth to mouth among the users or adopters may be effective to make the technology becomes socially accepted and recognized. To find out this question, the focus has been given on the network pattern among the adopters in next section.

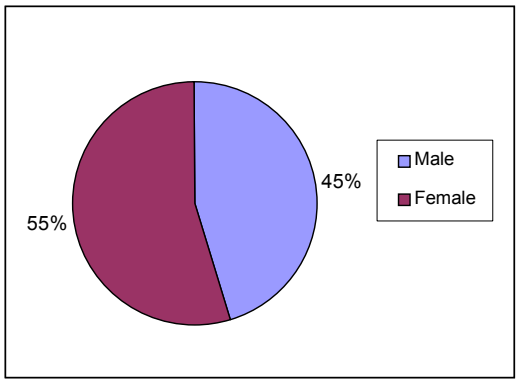
5.4.2 Social Implementation of Rainwater Harvesting Technology

5.4.2.1 Adopters Characteristic

The tank adopters who were interviewed in Sumida city are quite aged group of individuals, 64% of them belong to more than 60 year age group category (Graph 5.1). Majority of the respondents are female (Graph 5.2). 50 percent of the households are comprised by 1 to 2 members. Majority of this household are comprised by old couple of more than 60 years old (Graph 3). Only 12% of tank adopters have reported that they have children (Table 1). Presumably, the tank adopters are economically well established. 66% of the tank adopters have car at house (Table 5.3).



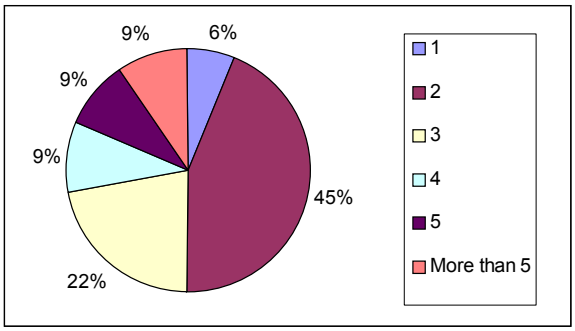
Graph -5.1 Distributions of tank owners according to Their Age



Graph – 5. 2 Sex ration of Tank Owners

	Yes	No
Having Children	4 (12%)	27 (88%)
Having Car	19 (61.29%)	12 (38.71%)

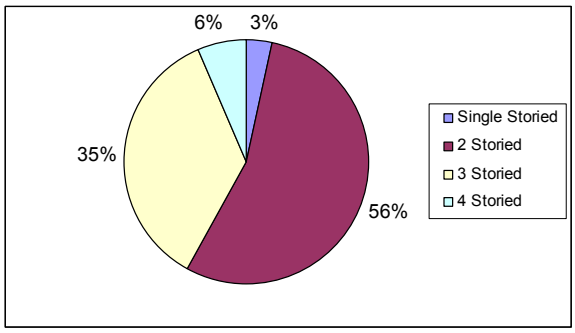
Table – 5.3 Household characteristics of the Tank adopter



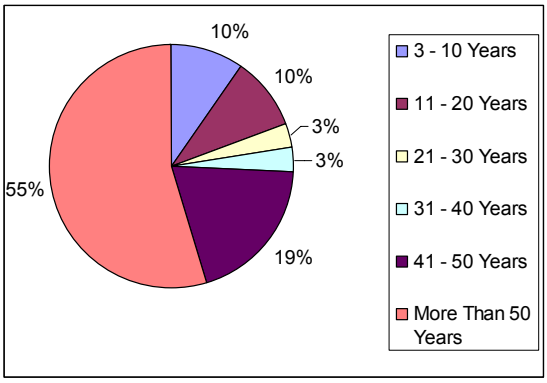
Graph - 5. 3 Household Size of the tank adopters

5.4.2.2 Housing Characteristics

All the tank adopters are the owner of their house. A higher percentage of the houses are two storied building (Graph 5.4 4). 50 % of the houses are reported as wooden or timber and rest of the 50% are non-timber houses consist of still frame and reinforced concrete construction. Significantly, wooden are houses are quite old. The adopters have been living in this area for a long time. Majority of them have been staying in Sumida city for more than 50 years. Only 10 % of the respondents are those who migrated to this area in between last 10 years (Graph 5).



Graph – 5. 4 The highest of the houses where the rainwater tanks are set up



Graph 5.5 Period of staying in the area

5.4.2.3 Rainwater Tank - Size, Cost and Shape

In Sumida, two types of tank capacity at household level are observed – 200 liters and 250 liters. The tank has been installed through the help of Sumida City office, however, two respondents have reported that apart from the Sumida City Office's tank, they have also built and installed extra tanks by themselves. Out of 33 tank owners, 4 tank owners installed more than one tank in their house. The cost of the tank varies from 43000 Yen to 62000 Yen. All the respondents have received subsidy from the Sumida City Office for tank

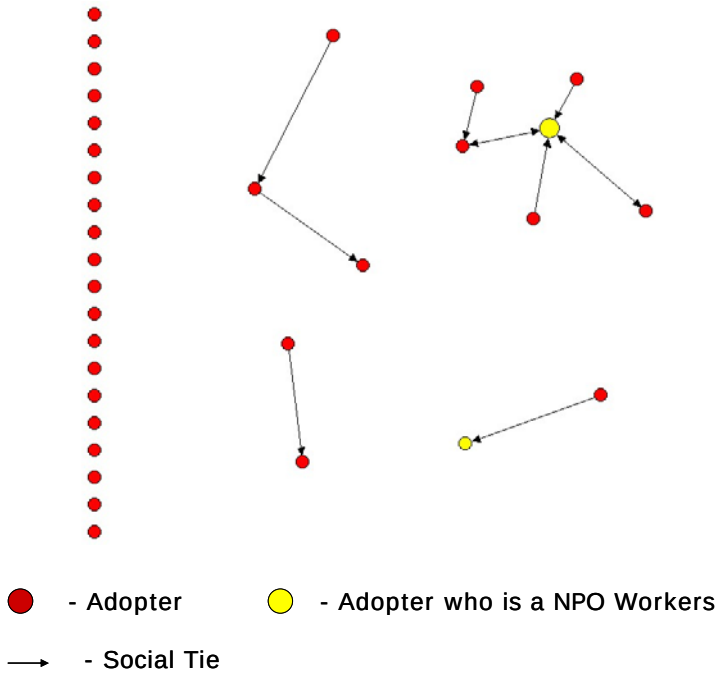
Pic – 5. 1 All the tanks are ring shape

installation. The half of the tank cost has been provided by the Sumida City Office and the rest of the cost is covered by the beneficiaries. All the tanks are ring shape.

5.4.2.4 Social Networks of Information Sharing

In order to understand the tank dissemination process, the focus has been given on the interpersonal contacts among the adopter. Fig. 5.2 shows that that majority of the adopters are isolated. A social network among the adopters is negligible. A few of the adopters are connected with the NPO workers who are also the inhabitants of Sumida. Therefore, tank adoption by some individuals did not create any social pressure to other individuals, rather since the adopters sparsely distributed; tank installation of by them may have been treated as an isolated action and decision. Lesser social network density on the other may not help the adopter to learn from others who have already adopted it. Now the question is how the adopters have learned about the tank? To examine such question, the study focuses more intensively on the information sharing activities of the adopters.

Fig. 5.2 Interpersonal contact (Social Networks) among the adopters in



Social Networks of hearing (Fig. 5. 3) shows that the role of community members is nearly zero. Adopters heard mainly from the Sumida City Office, NPO workers and Mass media. Thus, receiving information from mass media and change agent agents, a group individuals took adoption decision which may not influence any other community members and as a result the information did not diffuse from mouth to mouth.

Like hearing, similar trends has been found in case of observation as shown in Fig. 5.4. Adopters mainly observed the tank at Sumida city Office, NPO office or in mass media like TV, News papers or internets. In a very few cases, adopters were known about the tank by observing the tank installed in their locality.

Fig. 5.3 Social Networks of Hearing in Sumida City

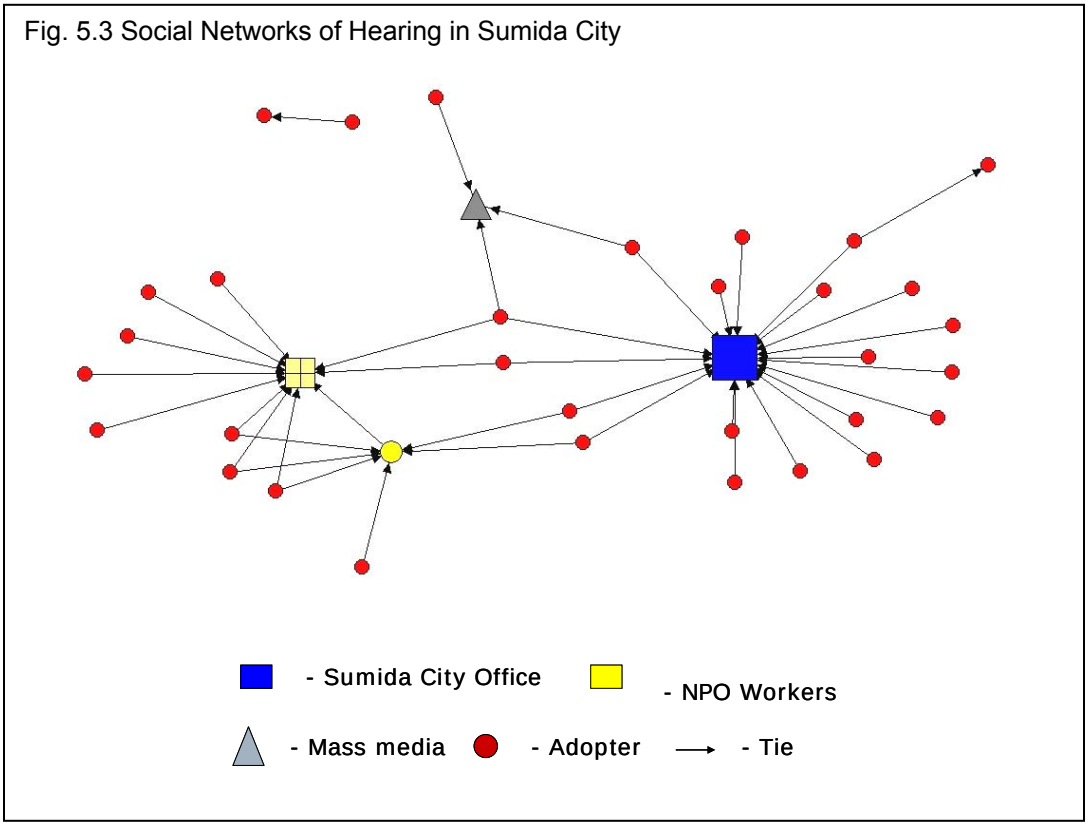


Fig. 5.4 Social Networks of Observation in Sumida City

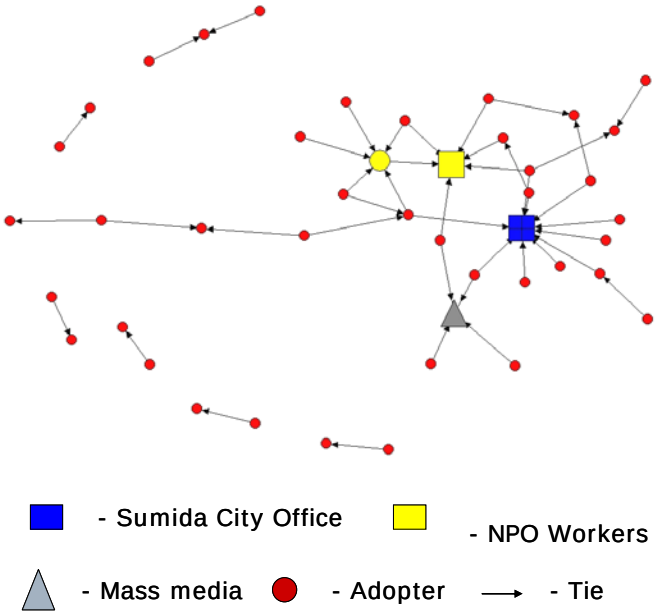
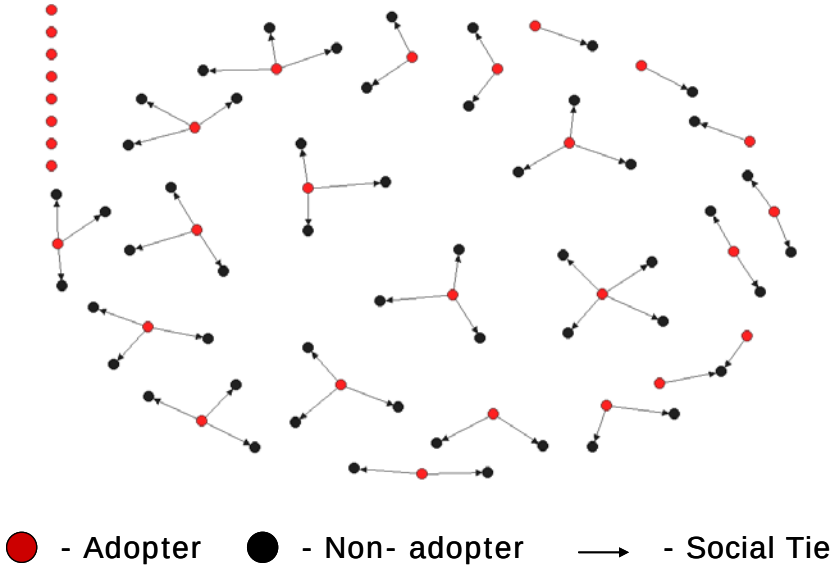


Fig. 5.5 Social networks of adopters and the individuals who are asked by the adopters to install the



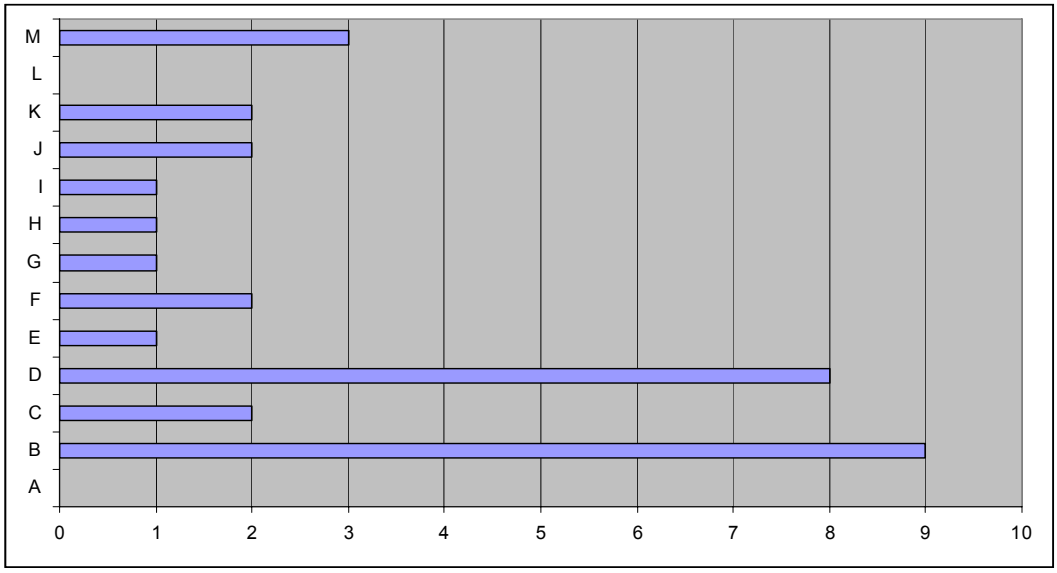
Therefore, social networks did not develop in the first phase of the diffusion. However, those who adopted the tank, a good number of them passed information to the non-adopters, particularly to their neighbors (see Fig. 5. 5). Therefore, social networks of information sharing started to develop in the second phase of the technology dissemination process, i.e., after a few individuals adopted it. But this social network

could not trigger the technology dissemination process as Fig 5. 4 show that the adopters informed to their network partners but the tank was not installed by them. Adopter reported that due to space problem, lack of motivation, having adequate alternative water sources, those who were informed about the tank have not installed the tank. For example, a female adopter in Sumida as mentioned - “I informed to a lot of my neighbors. But I think they are not interested because they told me that they have alternative water source and the rainwater tank is little expensive”. Another adopters mentioned - “I was motivated by Sahara san. But, I did not inform my neighbors, because most of the houses in this area have not enough space to set up the tank. ”

The ineffectiveness of the social network may be traced out by focusing on the reasons that motivated a stipulated group of individuals to install, the characteristics of the tank, its advantages and disadvantages.

5.4.2.5 Reasons of tank installation

There is no common ground that motivated the adopters to install the tank, rather various personal feelings, opinions and views lead to the tank installation (Graph 5.6). However, rainwater tank as an efficient disaster preventive measure and as an alternative technology for effective utilization of rainwater appeared as the main motivational factors for tank installation. A lady, over 70 years of age, who installed this



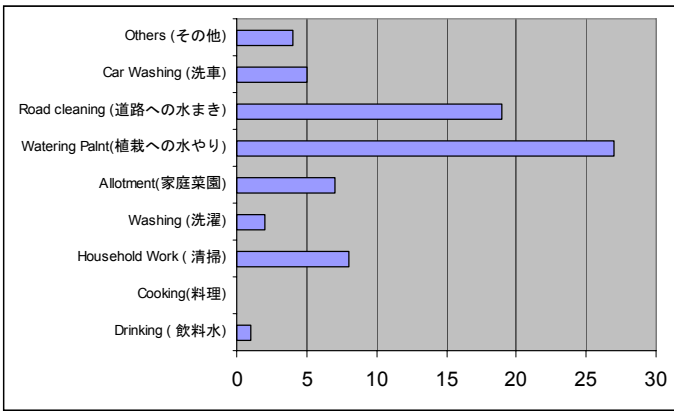
A) きれいな水を得るため (To get pure water)
B) 災害時の消火等に役立てるため (Disaster prevention)
C) 水道代削減のため (Reduce water bill)
D) 節水対策のため(save water)
E) 渇水対策のため (Drought management)
F) 環境に配慮するため(Eco-friendly)
G) 友人や隣人が使っていていたから (Observing others)
H) 友人や隣人に促されたため (Friends recommend)
I) 街中で設置されているのを見て(Street Furniture)
J) 製作者のことを知っていたから(Knowing produces)
K) 墨田市に勧められたため(Sumida-ku office encouraged)
L) 墨田市の補助金が使用できるため(Getting Subsidy)
M) の他(Others)

Graph – 5.6 Reasons of tank Installation

tank just after the Hanshin-Awaji earthquake mentioned as – "During Kobe earthquake, watching people's misery in TV, I realized the importance of this sort of rainwater tank. So I decided to install the tank". In some cases, more personal spiritual feelings motivated the individual to install the tank. For Example, a woman of more than 60 years old installed the rainwater tank for the following reason - after her father death, she was mentally upset and was planning to do something so that she could respect her father soul. Seeing the rainwater tank, she realized that if she can install this tank and watering plant by rainwater tank, it may give her feeling that she might show respect to her father's soul. She informed that whenever she does watering plant by using rainwater tank, she feel she can touch her father soul. Therefore, though the adopters are common individuals, but their motivation of tank installation derived from unique personal factors rather than any collective reasons of tank installation.

5.4.2.6 Use of Tank Water

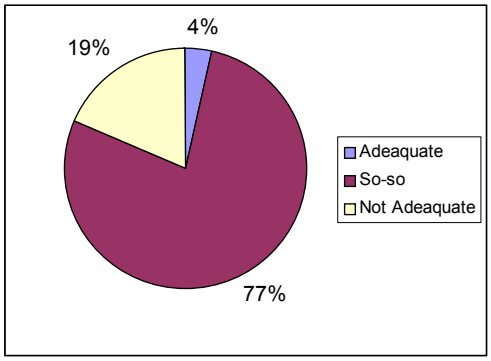
The use of tank purpose is very limited. Tank water is mainly used for domestic purpose like – watering plant, cleaning roadside or courtyard. Watering plant or gardening is the most observed common purpose. Except one household, non of the tank owners use rainwater for drinking and cooking purpose as they feel that this water is not safe and clean enough to drink and also they have alternative drinking water source (5.7). It seems that limit use of the tank could not create interest among the other non-adopters.



Graph – 5.7 Use of tank water

5.4.2.7 Water Storage Capacity

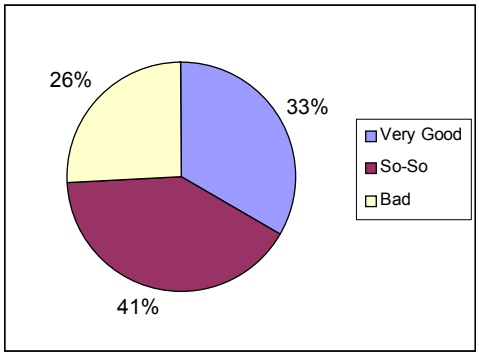
A large number of the tank owners feel that tank capacity is so-so or not adequate, and they prefer a bigger size of the tank (Graph 5.8). The tanks owners feel that the tank is not sufficient in case of emergency, like - fire fighting. The tanks are almost empty during dry season. Though a bigger capacity of tank is preferred, yet a wider space is required to install the bigger tank. Therefore, they feel that tank suppliers like 'Sumida City Office' must consider these issues and design the tank accordingly.



Graph – 5.8 Water storage capacity of the tank

5.4.2.8 Water Quality

Various views about quality of tank water have been observed. 33 % of the tank owners think that the tank water is very clean and it can be even used for drinking in case of emergency, like – post-earthquake period. However, 26 % of the

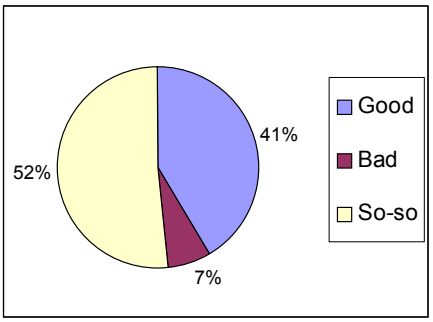


tank adopters have found the quality of the tank is not good (Graph 5.9) as they have found particles, muddiness in water and sometimes the tank itself is a breeding ground for mosquitoes. Design of the tank has been reported as a reason behind bad quality of water. A few tank owners think that since tank water used as watering plant clearing courtyards, the quality of water is ok.

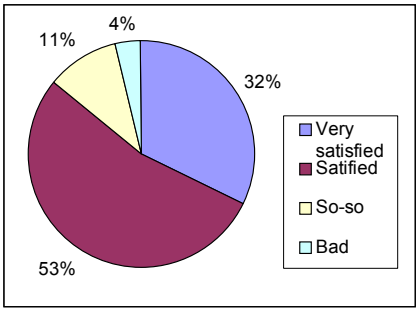
5.4.2.9 Tank Design

It has been observed that the tank owners are very choosy about the tank design. More than half the tank owners are dissatisfied with the tank design which includes color, size, shape and other various hardware components (Graph 5.10). A good number of respondents wanted to change the color of the tank. As one of the responded informed us – "since the color of the tank is blue, the dust on the tank body is easily noticeable. The tank color should be brown which is more natural and easy to maintain". The owners also feel that the tank design should be more attractive, so that it could be used as furniture in the garden.

Most the respondents reported that the water level indicator does not function well. Due to muddiness and the poor quality of glass, the level of water is hardly visible. As a result to know the water level, they need to open the head of the tank. The tank's tap or faucet is also very tight to rotate and reported as not well functioning. Tank design including color, shape, and size are the components which are recommended by the adopters to be improved.



Graph – 5.10 Tank design



Graph – 5.11 Satisfaction level of the tank adopter

5.4.2.10 Satisfaction Level

Since the adopters were motivated to install the personal for personal reasons, overall satisfaction level is high as shown in 5.11. However, it shows a significant numbers of adopters are not satisfied with the tank, who have recommended the improvement of the

Disadvantages	Tank Owners
高額である (Expensive)	4%
水質が良くない (Poor water quality)	4%
容量が十分でない (Inadequate Capacity)	0%
デザインがよくない (Poor Design)	0%
維持管理が大変である (Maintenance Problem)	4%
そうじがしにくい(Cleaning Problem)	31%
場所を取る (Space Problem)	19%
その他 (Others)	38%

Table – 5. 4 Disadvantages of the Rainwater tank

tank in terms of tank design, cost, water quality, capacity etc. Cleaning tank is reported as the most common problem (Table 5.4). Since the tank is quite heavy and difficult to move, and there is no proper drainage system, it is difficult for the tank owners to clean the tank. A few recommended that a literature or cleaning guidance catalog should be given to the tank owners for its proper maintenance. During our study, we found very rare individuals who clean the tank at least in a year. Tank design including color, shape, and size are the others components which are recommended to be improve. The adopters prefer a filtration device in the tank, so the water quality of the tank will be improved.

Though, the advantages of rainwater as reported by the owners are more societal or communal than personal benefits (Table 5.5). Rainwater tank has been indentified as an effective fire fighting measure, eco-friendly and a technology of effective utilization of rainwater. Personal benefit or advantages like reducing water utility cost, watering plant are reported by some, however, not significant adopters.

Advantages	Tank Owners
水道代が削減できる(Reducing utility cost)	12%
設置に補助が得られる(Set up give aid)	0%
きれいな水が得られる(getting pure water)	0 %
災害時の消火等に役立てられる(disaster and fire fighting)	15%
環境に配慮できる(Eco-friendly)	28%
雨水に対する考えが変わった(utilizing rainwater)	27%
その他 (others) – gardening facility, road maintenance)	18%

Table –5.5 Advantages of the Rainwater tank

5.4.2.11 Time taken after knowing about the tank

The tank adopters did not take much time after they have learned about it. Near about 50% of them installed the tank within one or few months just after knowing about it (Table 5.6). The efficiency of the Sumida City Office to provide relevant information and their quick installation capacity has been reported as the crucial factor for not taking much time once the adopter learned about it. Space problem to set up tank is reported as the biggest problem to install the tank just after hearing about it. A very few took comparative longer time who think that they were not motivated or they did not have adequate information about the tank.

Time Taken	Tank Owners
Within a Month	46%
More than a Month	3%
1 year	21%
5 Years or More	10%
Unknown	20%

Table – 5.6 Time Taken by the adopter to Install the tank after they have learned about the Tank

5.5 Summary

In this chapter social network development process has been examined and analyzed at two levels in order to understand the innovation dissemination process. In the first section, the focus has been given on social networks among the players to under understand the structure of the organization that foster the dissemination of innovation.

Three players including comrades, appreciators and circulators took a key role in this process. In the initial phase, the role of comrade and appreciator and their network formation with the inventor helped to trail the technology. Circulator appeared in the post-trail phase and disseminated the message inside and outside the region. The network development of appreciators and comrades helped mainly the local region or community to take the fruits of innovation, whereas circulator helped both the local community as well as the imitators to cultivate the technology and become benefited of it. As the dissemination progressed, more and more players appeared into scenario and dense network has been established among the players, which helped to disseminate the innovation from inventor to the end users.

Information about the rainwater tank among the end users did not flow through interpersonal connection; rather adopters received information from the mass media, like Sakura TV, internets, news papers, and newsletters of the ward office. Except a very few, none of the adopters have heard about the tank prior to their adoption from their social network partners like friends, neighbors, relatives or any acquainted person. Moreover, adopters neither observed neighbors' tank, nor they discussed about the tank with any of their social network partners. Therefore, social networks did not develop in the first phase of the diffusion. However, those who adopted the tank, a good number of them passed information to the non-adopters, particularly to their neighbors. Therefore, social networks of information sharing started to develop in the second phase of the technology dissemination process, i.e., after a few individuals adopted it. But this social network could not trigger the technology dissemination process. As the study found that hearing from the adopters or observing their tank, none of the social network partners adopted the tank. The study has identified two main reasons behind the ineptitude of social networks.

First, attributes of the innovation or rainwater harvesting tank need to be improved, particularly use of rainwater tank need to be widen. The study found that the tank serves limited purposes, like watering plant, cleaning roadside. Moreover, the local community has efficient and reliable water supply system from the Sumida City Office. Therefore, the tank with its limited use neither become an alternative source of water, nor it can offer any extra assistance for the individuals, which the city water is unable to provide. Lack of such capacity or use can not make this innovative technology becomes inevitable for the community members. Along with this, the aesthetic value of the innovation is also reported as low. Adopters of the tank mentioned that they are not fully satisfied with the color, shape, size of the tank. In addition, quality of water is not good; water level indicators are not properly functional. To become an attractive and viable water supply system or source, modification of all these aspects of the tank are recommended by the adopters. Since the tank has above mentioned disadvantages, there is no common reason or social ground for tank installation, rather individuals adopted the tanks because of more personal feelings, values, emotion etc. Isolated requirements or individual motivation only rendered the diffusion process among a segregated group of individuals. Therefore, improvements and modification of those components of the rainwater tank is instrumental to create a social base of technology dissemination which can be triggered afterward by the process of social network of information sharing.

Second reason behind the ineffectiveness of social network is that since a segregated group of individuals have been adopted the tank, their adoption decision presumably have been considered as an isolated social activity by the other members of the

community. Therefore, neither it has created social influence or social pressure to the other members of the community, nor it becomes a source of learning for them. As the study found that though the adopters after their adoption informed about the rainwater tanks to their neighbors, but neighbors did not pay heed into it.

Apart from the above mentioned issues, space problem and cost constrains of the tank are found as the most crucial hurdles for the tank installation. On the other hand, it is found that once the innovation fit for the individuals' need, majority of the adopters took only 1 months to install the tank just after they learned about the tank, and such a quick implementation become possible as most of the adopters feel that the implementing agency, Sumida City Office is very efficient to provide relevant information and also to install the rainwater tank.

Based on the above finding, it is quite clear that creating a social base or needs for further dissemination of rainwater tank is inevitable. Widening the use of rainwater tank through up-gradation and modification of the existing rainwater harvesting tanks may make such social base. The next chapter deals with such issues.

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Chapter – 6: Adaptive Management Strategies for Rainwater Harvesting Technology Implementation

6.1 Introduction

Rainwater harvesting is an effective technology to fight with various kinds of water pollution risks. However, the social implementation of the technology is required in order to diffuse the tank among wider parts of the community both in Japan and Bangladesh. The findings of previous chapters show that there are different diffusion trends and patterns of rainwater harvesting in these two areas. Implementation of rainwater harvesting tank in these two regions are different in respect of - the purpose of tank installation, the reason of tank inducement, growth of tank installation, and level of knowledge about rainwater tank. However, the tank diffusion in both these regions is confined within a particular group of individuals. To promote rainwater harvesting technology at wider level, it is instrumental to identify the factors behind not-installation of tank by the other members of the community. Presumably, different factors are involved behind the tank installation problem in both regions. This chapter focuses on the in-depth study of non-adopters of the tank in both regions. The study attempts to find out the local and regional issues affecting rainwater tank implementation at wider level. Morrelganj town, arsenic prone area of coastal Bangladesh, and Sumida city of Tokyo are taken as case study areas for this study.

6.2 Case Study – 1: Arsenic Prone Coastal Bangladesh

6.2.1 Background

In the arsenic affected coastal areas of Bangladesh, the tank has not disseminated among all sections of the community. Tank adopters are the elite group of individuals in the locality. Majority of the tank adopters have higher income, engaged in non-agricultural sector, well educated and also they are quite highly educated. Social network that developed among the individuals motivated only these affluent groups of individuals to adopt the tank through social learning and social influence. However, large sections of the local community are living below poverty line, illiterate and mainly engaged as wage laborers in the unorganized sector. Lack of various capitals force these groups of individuals to live at risks and drink arsenic contaminated water. To make the local community becomes resilient; the rainwater harvesting tank needs to be implemented among all sections of the community. The Micro-credit system was introduced and tested in the region in order to disseminate the tank among the poor. However, the micro-credits system could not cover the poor people as they can not repay back the money. So, due to lack of financial capital, the poor people are unable to take the benefit of the technology. Apart from economic factors or affordability of the individuals, individuals' willingness to adopt the tank may also contribute to the effective implementation of the technology. Individual's willingness may depend on level of education, degree of knowledge and information, awareness, extent of social networks, income, occupation, sources of drinking water, level of vulnerability etc. The present study attempts to find out -

1) Individual's degree of wiliness and the factors influencing their degree of willingness for tank installation in the arsenic prone coastal areas
2) To identify the factors due to which the interested individuals are unable to install the tank
3) To identify and design the affordable cost of the tank for the local community.

6.2.2 Methods

The field survey has been conducted in Morrelganj town where the rainwater tanks have been already adopted by few individuals. The survey has been conducted among 44 individuals who have not adopted the tank. The head of the household who is the main decision maker of the family has been interviewed. The respondents have been selected randomly. All of the respondents are male members. Face-to-face interviews have been conducted by taking the help of local leaders.

6.2.3 Results

Attributes of Individual

The study has been conducted among 44 individuals. The individuals have different socio-economic background as reflected in table 6.1.

Table – 6.1 Social, economic and cosmopolitan nature of the respondents

Socio-Demographic Characteristics		
Household Size	Frequency	Percent
Up to 4 members	11	25
5 - 6 members	24	54.4
7 – 8 Members	7	15.9
9 members or more	2	4.5
Age groups	Frequency	Percent
Up to 30	8	18.2
31 – 40	14	31.2
41 – 50	12	27.3
51 – 60	10	22.7
Level of Education	Frequency	Percent
Illiterate	6	13.6
Primary level (Up to class 4)	8	18.2
Junior High School Level (Up to Class 8)	9	20.5
Secondary level (Up to Class 10)	6	13.6
Higher Secondary level (Up to Class 12)	11	25
Under-Graduation	3	6.8
Post-Graduation	1	2.3
Economic Characteristics		
Occupation	Frequency	Percent
Agriculture	3	6.8
Wage laborer and Informal Sector	14	31.8
Business	14	31.8
Government Service	6	13.6
Private Sector	7	15.9
Income (In Taka -)*	Frequency	Percent
Up 1000 taka	5	11.4
1100 – 2000 Taka	7	15.9
2100 – 4000 Taka	12	27.3
4100 – 6000 Taka	8	18.2
6001 – 8000 taka	7	15.9

More Than 8000	5	11.4
Cosmopolitan Nature		
Watching TV (In a Week)	**Frequency**	**Percent**
Never	18	40.9
Once in a week	5	11.4
Everyday	21	47.7
Reading Newspaper	**Frequency**	**Percent**
Never	23	52.3
Once in a week	7	15.9
Everyday	14	31.8
Visiting Nearest City (Khulna) in a year	**Frequency**	**Percent**
Never	5	11.4
1 in a Year	10	22.7
2 in a year	5	11.4
4 in Year	6	13.6
6 In year	1	2.3
12 in year (Every Month)	8	18.2
24 in a Year (2 Times in Week)	5	11.4
48 in a Year (Every Week)	4	9.1

* US $ 1 = 69 Taka

Source of Drinking Water and Drinking Water Problem

Three types of drinking water source have been observed. However, those who depend on tube-well, few of them have their own tube-well and others don't have their own tube-well. Those who don't have their own tube-well, they collect water from public tube-wells or from neighbors' tube-well. Pond-sand-filter (PSF) has been reported as the source of water on which highest numbers of individuals depend. Only 20.5 % (9 individuals) reported that they don't face any water related problem. Health problem and water fetching problem have been observed as the two most water related problem. Individuals who depend on pond for drinking water have the highest level of problem, whereas individuals who depend on tube-well have relatively lesser water related problem. The sources of water and water related problem is moderately correlated (Pearson correlation = - . 419; $P < 0.01$).

Table – 6.2 Sources of Water and Water Related Problem

	Sources of Water				Total
	Pond	Tube –well (owned)	Tube –well (not-owned)	Pond-Sand-Filter (PSF)	
No. of Individuals	**9 (20.5%)**	**9 (20.5%)**	**7 (15.9%)**	**19 (43.2%)**	**44 (100%)**
Water Problem					
Odor	13.6 %	2.3 %	2.3 %	6.8 %	25 %
Test is not good	15.9 %	4.5%	4.5%	4.5%	29.5 %
Water has bad color	15.9 %	4.5%	2.3%	11.4%	34.1%
Health problem	13.6 %	15.9 %	6.8 %	11.4 %	47.7%
Water Fetching Burden	9.1%	2.3%	4.5%	27.3%	43.2%
Not- Available for whole Year	13.6 %	0%	2.3%	11.4%	27.3 %
No Problem	2.3 %	4.5%	4.5%	9.1%	20. 5 %

Table – 6.3 shows that there is no correlation between social, economic, cosmopolitan nature or condition of individuals and water source and water related problem. It indicates that all section of the individuals irrespective of their social and economic status are having water related problem. All categories of individuals are facing water related problem.

Table – 6. 3 Correlation between Individuals characteristics and water source and water related problem

Kendall's tau-b	**Socio-Demographic Characteristics**			**Economic Characteristics**		**Cosmopolitan Nature**		
	Household size	Age	Education	Occupation	Income	Watching TV	Reading Newspaper	City Visit
Water Source	.189	- .139	.130	.149	.068	.077	-.005	.240
Water Problem	.042	-.024	-.127	-.146	.057	-.104	-.035	-.167

Level of Knowledge

Majority of the respondents know about the rainwater tank. Table 6.4 shows that 77.3 % of respondent know about the size and structure of the tank. Other information like – 'cost of the tank' and 'who built this tank' are also known to a good number of individuals. However, a very few individuals attended the meeting or workshop on rainwater harvesting organized by the NGO. Only 25 percent of individuals reported that they have no knowledge about the rainwater tank (Table 6.5).

Table – 6. 4 Individual's Knowledge about various aspect of rainwater tank

Knowledge of tank	Yes	No
Size and structure	77.3	22.7
Cost	40.9	59.1
Who Built the tank and How to built	47.7	52.3
Attended any meeting	9.1	90.9

Table – 6. 5 Degree of Knowledge about Rainwater Tank

Degree of Knowledge	Frequency	%
No Knowledge	11	25
A little (at least 1 aspect)	8	18.2
Little (at least 2 aspect)	10	22.7
Well Known (at least 3 aspect)	11	25
Very well known (all aspect)	4	9.1

Out of 44 respondents, only 3 individuals have reported that they have learnt about the tank from TV broadcasted programme or from news paper reporting. Respondents have learnt about the tank by hearing from their social network partners like neighbors, friends, co-workers, and also observed the tanks in the town or outside the tank. Table – 6.6 shows that adopters level of knowledge is moderately correlated with their education, income, reading newspaper and also with their hearing and observation network. Therefore, social network may help individuals acquire knowledge.

Table – 6.6 Correlation (Kendall's tau-b) between Level of knowledge and Individuals characteristics and social network

Kendall's tau-b									
Household size	Age	Education	Occupation	Income	Watching TV	Reading Newspaper	City Visit	Hearing Network	Observation network
.039	.064	.338**	.221	.335**	.173	.344*	.218	.264*	.356**

** Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

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Reasons of not Tank Installation

Monitory problem has been observed as the major reason of the hindrance of tank installation. Interestingly, there is no correlation between individual's income and monitory problem for tank installation. It indicates that not only the poor people, but also the relatively affluent group of individuals also considered monitory constraint as their major reason of not tank installation. 18.2 percent of respondents have not installed the

tank because they have no idea about the tank. No idea about the tank is moderately correlated with education, income, reading newspaper and also with hearing and observation network. Since the adopters' level of knowledge is significantly correlated with education and hearing and observation networks as shown in the previous section, therefore, education as well as individual's social network helped them to learn about the tank. Cosmopolitan nature like reading newspaper has also a significant role in this regard. Those who were not conscious and those who had no water problem, no socio-economic or cosmopolitan characteristic are correlated with their reasons of not tank installation. Interestingly, no individual considered that the technology is not good.

Table – 6.7: Reason of not-installation of tank yet and its relation with characteristics of individuals and level of knowledge

	Reason of not-installation of tank					
	I had not enough Money	I had no Idea	I don't know how to do it	I Think that I was not Conscious	I had no water problem	This is not a useful technology
No. of Individual	**16 (36.4%)**	**8 (18.2%)**	**7 (15.9%)**	**9 (20.5%)**	**4 (9.1%)**	**0**
Correlations (Kendall's Tau-b)						
Household size	.256	.023	.128	.212	.015	NA
Age	.192	- .194	.005	.139	-.098	NA
Education	.116	-.378 **	.132	.099	.099	NA
Occupation	-.061	-.329**	.275*	.053	.088	NA
Income	-.007	-.367**	.077	.209	.104	NA
Watching TV	-.031	-.205	.156	-.027	.091	NA
Reading Newspapers	.423**	-.442*	-.093	.018	.039	NA
Visiting City	-.040	-.238	-.039	.150	251	NA
Water Source	-.167	.041	.031	.063	.031	NA
Water problem	.156	.006	-.090	.272*	-.292*	NA
Level of knowledge	.314 **	-. 455**	-.061	.073	.065	NA

** Correlation is significant at the 0.01 level (2 tailed)
* Correlation is significant at the 0.05 level (2 tailed)

Willingness of Tank Installation

Table 6.8 shows that only 27.3 % of the individuals don't want to install the tank. Those who don't want to install the tank, they don't have any water problem or they did not have idea of the tank. Therefore, due to lack of knowledge a few individuals don't like to do it. Those who intended to do it; money is the major problem of tank installation. Though monitory problem has been identified as the most crucial problem behind not installation of tank, however, factors like - lack of knowledge how to due it, no idea and consciousness are also reported as the reasons behind hindrance of tank installation.

Table – 6.8 Cross-tabulation of willing to adopt the tank and the reason behind not installation of tank earlier

		Why did not install Earlier					
		I Could not do it because of monitory problem	I had no idea	I don't know how to do it	I was not conscious	I had no water problem	Total
I want to install the tank	Count	15	1	7	4	5	32
	% of Total	34.1%	2.3%	15.9 %	9.1%	11.4%	72.7%
I don't want to install	Count	1	7	0	0	4	12
	% of Total	2.3%	15.9%	0%	0%	9.1 %	27.3%
Total	Count	16	8	7	4	9	44
	% of Total	36.4%	18.2%	15.9%		20.5%	100%

Affordable Money

The affordable money is not only correlated with the occupation and income, but it is also moderately correlated with education, cosmopolitan nature, and level of knowledge. It indicates that the higher income group people are not only willing to pay more money for tank installation, but the individuals who are having higher knowledge, education and more cosmopolitan, they also like to pay more money. Interestingly, there is no co-relation between water source or water problem and affordable money. Since the social network including hearing and observation is positively correlated with the level of knowledge, therefore, hearing and observation related social network may motivate individuals to pay more money.

Table 6.9 Correlation between affordable money and various other factors

	Correlation Coefficient (Kendall's tau-b)	Significance (2 tailed)
Household size	.041	.749
Age	.008	.949
Education	.417**	.000
Occupation	.441**	.000
Income	.420**	.000
Watching TV	.315*	.015
Reading Newspapers	.299*	.020
Visiting City	.133	.263
Water Source	.097	.438
Water problem	.096	.426
Level of knowledge	.446**	.000

** Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

From the above analysis, it is found that individuals level of knowledge which is correlated with their level of education and their hearing and observation network, may influence their motivation to adopt the tank and also their level of willingness to pay the money for tank installation. However, since economic factor is the crucial component which influences their affordability level, it is inevitable to check the individual's level of affordability and their economic characteristics. Therefore, the individuals' affordability has been crosschecked in relation with their occupational category and income level.

Table 6.10 shows a good number of individuals are willing to pay 15000 taka which is the present cost of the tank. Those who have willingness to pay whole the cost of the tank, majority of them are engaged in the business sector or private services. Wage laborer or the individuals involved in the informal sector can only afford a relatively lower amount of money for tank installation. However, table 6.11 shows those who prefer to pay the highest money, all of them do not belong into higher income group. It seems that individuals' willingness to pay does not only depend on their income level, but their level of education, level of knowledge is significantly correlated with it. Table 6.10 and 6.11 show that there are three categories of level of affordability of tank installation – a) an extremely poor group of individuals who can only afford 2000 taka for tank installation. They are mainly wage laborer, agriculture hawkers, hawkers, rickshaw-puller whose monthly income is hardly 2000 taka. B) A relatively middle income group of individuals who can afford 4000 taka to 6000 taka. They are businessman, government and private sector employees. C) There is also a group of individuals who are willing pay the whole amount.

Table – 6.10: Cross- tabulation of Occupation and Affordable Money

			Affordable Money (In Taka)							Total
			.00	1000.00	2000.00	4000.00	6000.00	10000.00	15000.00	
Occupation	Agriculture	Count	1	1	1	0	0	0	0	3
		% of Total	2.3%	2.3%	2.3%	.0%	.0%	.0%	.0%	6.8%
	Wage Laborer and Informal Sector	Count	6	3	2	3	0	0	0	14
		% of Total	13.6 %	6.8%	4.5%	6.8%	.0%	.0%	.0%	31.8%
	Business	Count	2	0	2	3	2	1	4	14
		% of Total	4.5%	.0%	4.5%	6.8%	4.5%	2.3%	9.1%	31.8%
	Govt. Service	Count	2	0	0	1	2	0	1	6
		% of Total	4.5%	.0%	.0%	2.3%	4.5%	.0%	2.3%	13.6%
	Private Sector	Count	1	0	0	0	2	0	4	7
		% of Total	2.3%	.0%	.0%	.0%	4.5%	.0%	9.1%	15.9%
Total		Count	12	4	5	7	6	1	9	44
		% of Total	27.3 %	9.1%	11.4%	15.9%	13.6%	2.3%	20.5%	100.0%

Note : US $ 1 = 69 Taka

Table – 6.11: Cross-tabulation of Income and Affordable Money

			Affordable money (In Taka)							Total
			.00	1000.00	2000.00	4000.00	6000.00	10000.00	15000.00	
Monthly Income	1000.00	Count	3	2	0	0	0	0	0	5
		% of Total	6.8%	4.5%	.0%	.0%	.0%	.0%	.0%	11.4%
	2000.00	Count	2	2	2	1	0	0	0	7
		% of Total	4.5%	4.5%	4.5%	2.3%	.0%	.0%	.0%	15.9%
	4000.00	Count	3	0	3	1	2	0	3	12
		% of Total	6.8%	.0%	6.8%	2.3%	4.5%	.0%	6.8%	27.3%
	6000.00	Count	3	0	0	2	1	0	2	8
		% of Total	6.8%	.0%	.0%	4.5%	2.3%	.0%	4.5%	18.2%
	8000.00	Count	1	0	0	1	3	0	2	7
		% of Total	2.3%	.0%	.0%	2.3%	6.8%	.0%	4.5%	15.9%
	More than 8000	Count	0	0	0	2	0	1	2	5
		% of Total	.0%	.0%	.0%	4.5%	.0%	2.3%	4.5%	11.4%
Total		Count	12	4	5	7	6	1	9	44
		% of Total	27.3%	9.1%	11.4%	15.9%	13.6%	2.3%	20.5%	100.0%

Note: US $ 1 = 69 Taka

Findings from Case Study – 1

Water related risks and problems are common in the study area. The community is under immense threat of getting potable drinking water. All sections of the community irrespective of their socio-economic condition are under the threat of drinking water problem. Rainwater harvesting as an instrumental technology for fighting with such risks has been recognized by a majority of the community members. Individuals' level of knowledge about the tank is found as quite high. Instead of mass media, interpersonal contact or social networks helped the community learned about the technology. Observing others tanks or hearing from their social network partners, individual have learned about the technology. However, the higher income group, higher educated group of individuals has better knowledge about the various aspects of the technology. The study shows that, the majority of the individuals wish to install the tank. Those who don't want to install the tank, they either don't know about the technology or they have no such water related problem. A majority of the individuals wish to install the tank, however, lack of financial capacity and lack of knowledge are observed as the main stumbling blocks for tank installation. Apart from education, income, cosmopolitan nature of individuals, the social network of the community members helps them to acquire knowledge. Therefore social network has an important role in further tank installation. Focusing on the financial aspect of the programme, the study found that tank installation cost is not affordable for all section of the community. However, apart from income, individual's level of knowledge about the tank is positively correlated with affordability. Therefore, in order to motivate more people to install the tank, providing information to them is necessary and social network can play vital role in this case. Since the cost of the tank is not affordable to all section of the community, the focus need to be given on the affordable cost of the tank for all section of the community.

6.3 Case – Study: Sumida City

The findings of the previous chapter shows that rainwater tank have been installed by a selected group of individuals in Sumida City. In the first phase of the dissemination, social network has not been developed among the adopters and as a result no common factor has motivated the adopter to install the tank, rather personal feeling, emotion are attached with the individuals' adoption decision. Once the tank has been adopted by a group of individuals, they started to pass the information to their network partners. Thus, social network has been developed in the second phase, but it does not influence adopter's network partner to adopt the tank. Broadly three factors are indentified which may be responsible for lower rate of tank dissemination – a) Limited purpose - The tank has very limited use, mainly used for watering plant, cleaning roadside etc. Moreover, the local community has efficient and reliable water supply system from the local Government, Sumida City Office. Therefore, the tank with its limited use neither become an alternative source of water, nor it can offer any extra assistance for the individuals, which the city water is unable to provide. B) Ineffective design of the tank - the tank design has been identified as inappropriate. Adopters of the tank recommended improvement of the tank design including size, shape, color etc. Lack of space to install the tank is found as another important factor which may influence the adoption, c) The cost of the tank.

It is quite clear that creating a social base or needs for further dissemination of rainwater tank is inevitable. The present study hypothesis is that widening the use or purpose of rainwater tank through up-gradation and modification of the existing rainwater harvesting tanks will make such social base for the dissemination of rainwater tank at wider scale, though adopters' affordability should be taken into consideration. The study attempts to

find out the factors responsible for not adoption of rainwater tank by the local community members. The study also attempts to find out the level of knowledge about the tank among the individuals and their preferred design of tank and the reason of selection of such tanks by the individuals.

6.3.1 Methods

Based on the above mentioned study objectives, field survey have been conducted among the non-adopters of rainwater tank in the Sumida city. The sample size is 91. The study excluded the group housing and survey has been carried out only in the plot housing. The owner of the house has been targeted as a respondent. The respondents have been chosen randomly in the Sumida city. The questioners have been distributed to the respondent by taking the help of local leaders and the respondents have been asked to fill a set of questioners. The field up questionnaire sheets has been collected after few days of the distribution of the sheet. In order to know the individuals' preferred model or type of tank, information about 5 types of model of tanks have been attached in the questionnaire sheet. Information includes size ,cost , possible uses of the tank. It also includes the picture of the tank in order to give an idea of each tank to the respondent (See Appendix – 3).

6.3.2 Results

Housing and Household Characteristics

The higher percentage of household in the area is small as the Table shows that 50 percent of the households are having only 1 or two members. Majority of the respondent are the owner of their house. 2 storied building is the highest observed building height. Except a few houses, most of the houses have no lawn which indicates that the houses have no extra space. Tiles are the most observed roof materials, apart from that there are also concrete roof and tin roof. It seems that the most of the respondent have been staying here for long time as table shows that around 50 percent of the houses have age of 30 years or more, only a few houses have been built in last 10 years.

Table – 6.12 : Household and Housing Characteristics, Sumida.

	Frequency	Percent		Frequency	Percent
Household Size			**Roof Materials**		
1 Member	9	9.9	Tiles	46	50.5
2 Members	39	42.9	Concrete	19	20.9
3 Members	19	20.9	Tin	11	12.1
4 Members	10	11	Others	11	12.1
5 Members	13	14.3	I don't Know	2	2.2
Missing data	*1*	*1.1*	*Missing data*	*2*	*2.2*
Building Height			**Age of House**		
1	2	2.2	Up to 5 Years	9	9.9
2	59	64.8	6 – 10 Years	3	3.3
3	26	28.6	11 – 20 Years	14	15.4
4	4	4.4	21 – 30 Years	15	16.5
Missing Data	4	4.4	31 – 40 years	27	29.7
			41 – 50 Years	13	14.3
Housing Lawn			More than 50 year s	5	5.5
Yes	82	90.1	*Missing data*	*5*	*5.5*
No	7	7.7	**Housing ownership**		
Missing data	*2*	*2.2*	Owned	85	93.4
			Rent	6	6.6
			Missing data	*0*	*0*

Level of Knowledge

The level of knowledge about the rainwater tank is quite high among the respondent. More than 50 percent of the individuals heard about it from 3 or more person and the individual also observed the tank also in 3 or more places (Table 6.13). Only 25 percentage individuals never heard from anyone and only 7.7 percent individuals never observed the tank (Table 6.13). The cross tabulation of hearing and observation (Table 6.14) shows that only 6 individuals neither have heard about it and nor have observed that tank. Therefore, it seems that once an individual install this tank in the Sumida, they pass the information to their neighbors and their installed tanks become a source of observation for others.

Table: 6. 13 Individuals' degree of hearing and observation of rainwater tank

Hearing (From How many Individuals you have heard about the tank)	**Frequency**	**Percent**	**Observation** (How Many Places (House) You have Observed the Tank)	**Frequency**	**Percent**
None	23	25.3	None	7	7.7
From 1 Person	3	3.3	In 1 Place	8	8.8
From 2 Persons	6	6.6	In 2 Places	16	17.6
From 3 or more Persons	51	56	In 3 and more Places	52	57.1
Missing data	*8*	*8.8*	*Missing data*	*8*	*8.8*

Table - 6.14 : Cross-tabulation of hearing and observation of rainwater tank

			Observation (How Many Places (House) You have Observed the Tank)				
			Not Observed	In One Place	In Two Places	In Three Places	Total
Hearing (From How many Individuals you have heard about the tank)	From One Person	Count	0	1	1	1	3
		% of Total	.0%	1.3%	1.3%	1.3%	3.8%
	From Two Persons	Count	0	0	2	4	6
		% of Total	.0%	.0%	2.5%	5.1%	7.6%
	From Three Persons	Count	1	3	7	39	50
		% of Total	1.3%	3.8%	8.9%	49.4%	63.3%
	Not Heard	Count	6	4	5	5	20
		% of Total	7.6%	5.1%	6.3%	6.3%	25.3%
Total		Count	7	8	15	49	79
		% of Total	8.9%	10.1%	19.0%	62.0%	100.0%

Individuals not only observed the rainwater harvesting technology in the household level, but they also observed it in the public places, like Sumida city office building and other places. Around 60 percent of the respondent observed this technology in the public buildings (Table 6.15). Respondents are also quite aware about "Rojison" which is a mode of community level water harvesting system. In total, the idea of rainwater harvesting system is quite well known to most of the individuals.

Table - 6.15: Individuals' level of information about rainwater tank in the public places

Did you Observe Rainwater RWHT in the Public Building	**Frequency**	**Percent**	Do you Know about Rojison	**Frequency**	**Percent**
Yes	56	61.5	Yes	76	83.5
No	32	35.2	No	12	13.2
Missing	*3*	*3.3*	*Missing*	*3*	*3.3*

Individual's Perception about the Rainwater Tank

It seems that the resident of Sumida city like the idea of rainwater harvesting technology. Respondent were asked to rank the rainwater harvesting technology according to their opinion. All of the respondents reported that this is an effective and good idea (Table 6.16). None of them have reported that this is bad idea. More than 70 of respondent think that the local government should promote this kind of technology in the locality (Table 6. 17). Therefore, the community has a positive attitude about the rainwater harvesting technology.

Table- 6.16: Individuals' Opinion about the Rainwater Harvesting Technology

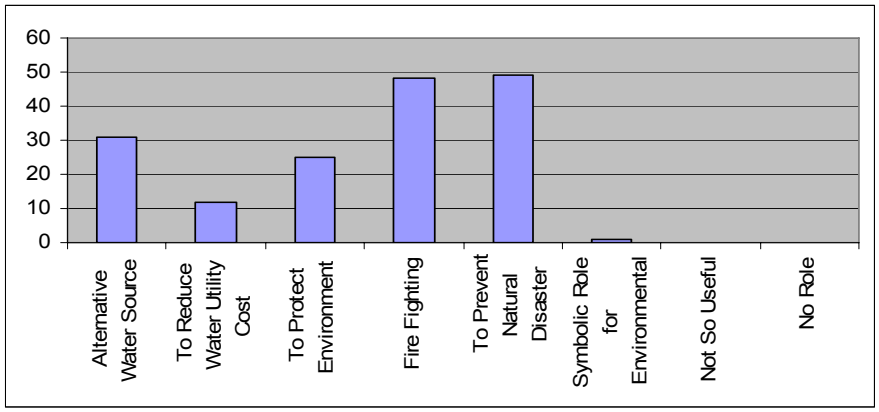
How is rainwater Tank according to your opinion	**Frequency**	**Percent**
Very Good	27	29.7
Good	51	56
So-so	10	11
Bad	0	0
Very Bad	0	0
Missing data	6	6.6

Table 6.17: individuals' opinion about the promotion of rainwater tank by the local Government

Do you think the local government should promote this technology	**Frequency**	**Percent**
Yes	66	72.5
No	19	20.9
Missing	6	6.6

Chart 6.1 shows that none of the adopters think "the idea is not useful" or it has "no role". Individuals considered it as a useful technology for fire fighting, preventing natural disaster, environmental friendly etc. In this regard, it is important to note that the respondent think that the technology is an effective device to fulfill community or societal purpose than individual or household purpose. As a result the technology as a disaster preventive technology, fire fighting, environmental friendly received higher score than 'alternative water source' or 'to reduce water utility cost.

Chart – 6.1: Potentials Role of Rainwater Harvesting Technology indentified by the non-adopters of tank



Reasons of Not Tank Installation

Though the technology has been recognized as an effective and useful device, but such technology has not been adopted by the individuals. The study identified (Table 6.18) that two major reasons for not installing the tank - the tank is expensive and the individual house has space problem to set up the tank. A significant number of individuals also think that the technology is not useful at household level.

Table – 6.18: Reasons of not Installation of Rainwater Tank

Reasons of Not Tank Installation	Score
I had no idea	6
I was not very sure about the tank	6
It is not useful	2
It is expensive	25
I have alternative water source	7
I have space problem	65
It is troublesome to set up the tank	1
I have no consultant	7
This technology is not suitable at household level	10
Rainwater is dirty	5
There are insects in rainwater tank	3
The design of the tank is not good	3
Others	1

Note - Valid N (listwise) = 82

Preferred Model of Rainwater Tank

Respondent have been provide information about 5 types of rainwater tank including size, structure, cost and possible uses of the tank. Based on this information, each respondent has been asked to select the best model according to their opinion. It is found that the reason of not installation of tank earlier and the selection of best model is connected. The higher percentage of individuals selected Tank 1 and Tank 2 as the best model out of the 5 types of tank. Tank 1 and Tank 2 is relatively small capacity rainwater tank and it is cheaper than the other types of tank. 8.8 percentage of respondent think that none of the model is good. Therefore, it needs to check the relation between selection of model and the reason of not installation the tank yet.

Table 6.19: Score of the each model of tank as the best model

Types of Tank	Frequency	Percent
Tank – 1	15	16.5
Tank – 2	22	24.2
Tank – 3	7	7.7
Tank – 4	8	8.8
Tank – 5	6	6.6
None	8	8.8
Missing data	*25*	*27.5*
Total	91	100

Table 6.20 shows that those who have not adopted the technology due to space problem, they preferred to adopt model -1 tank and model 2 tank which are smaller in size and required lesser space than the other types of tanks.

Table – 6.20 : Cross-tabulation of No-Space Problem and Type of Model selection

			Space Problem (tank has not been adopted because of space problem)		
			No	Yes	Total
Preferred Types of Tank	Tank – 1	Count	1	14	15
		% of Total	1.5%	21.5%	23.1%
	Tank - 2	Count	6	16	22
		% of Total	9.2%	24.6%	33.8%
	Tank – 3	Count	1	5	6
		% of Total	1.5%	7.7%	9.2%
	Tank – 4	Count	3	5	8
		% of Total	4.6%	7.7%	12.3%
	Tank – 5	Count	2	4	6
		% of Total	3.1%	6.2%	9.2%
	None of the Tank	Count	2	6	8
		% of Total	3.1%	9.2%	12.3%
Total		Count	15	50	65
		% of Total	23.1%	76.9%	100.0%

Table 6.21 : Cross-tabulation of Expensive and Type of Model selection

			Expensive (Tank has not adopted earlier because it expensive)		
			No	Yes	Total
Preferred Types of Tank	Tank – 1	Count	10	5	15
		% of Total	15.4%	7.7%	23.1%
	Tank - 2	Count	19	3	22
		% of Total	29.2%	4.6%	33.8%
	Tank – 3	Count	4	2	6
		% of Total	6.2%	3.1%	9.2%
	Tank – 4	Count	5	3	8
		% of Total	7.7%	4.6%	12.3%
	Tank – 5	Count	4	2	6
		% of Total	6.2%	3.1%	9.2%
	None of the Tank	Count	6	2	8
		% of Total	9.2%	3.1%	12.3%
Total		Count	48	17	65
		% of Total	73.8%	26.2%	100.0%

Table 6.21 shows that those you have not installed the tank because it is expensive, their choice of model is not concentrated in any particular form of tank, but all types of tanks have received the similar score including the bigger tank.

Reason of Preferred Model of Tank

The tank has multiple or various uses is the main observed reasons for selecting the particular tank (see Chart 6.2). It supports the study hypothesis that if the purpose of rainwater tank become wider then more people may prefer to adopt the tank. Less space requirement and reducing water utility cost has been reported as the significant reason of particular tank selection.

Chart – 6.2 Reason of Selection of Particular Model

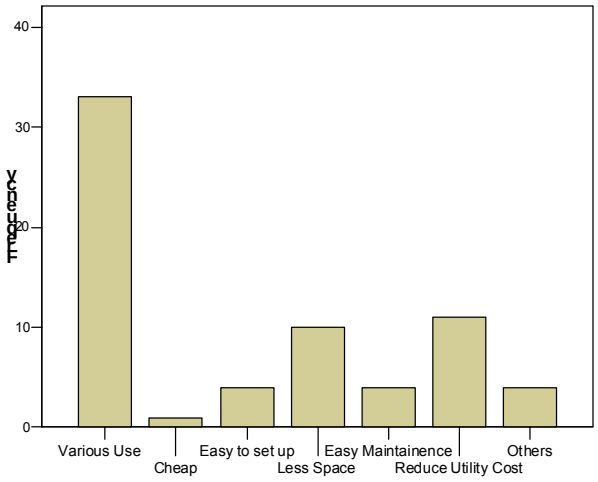


Table 6.22 shows that those who selected tank because it serves multiple purpose, their tank selection is not concentrated in any particular type, but all types of tank has been selected by them. However, the tank model 4 and 5 has been selected only because it has various or multiple use. Those who selected the tank because it requires lesser space to set up, all of them selected smaller tank including model 1 and 2. Therefore factors can be identified – 1) a group of individuals prefers smaller tank as because they have space problem to set up the tank, 2) on the other hand, a group of individuals prefers large space as because it serves multiple purposes.

Therefore, it is important to check the correlation between the reason of particular tank selection and the problem of space and expensiveness of rainwater tank. Those who have not install the model because of space problem, majority of them also want multiple purpose or in other words they selected the particular tank as because it serves multiple purpose. Similarly, those who have not installed the tank as because it is expensive, their reason of selection of particular tank as the best model is that it serves multiple purposes. Based on the above finding, it can be conclude that if the tank serves multiple purposes, it may motivate the individual to adopt the tank, however, the tank design should consider the lack of space.

Table 6.22 : Cross-tabulation of Types of Model and Reasons of Selection of Model

			Preferred Types of Tank						Total
			Tank – 1	Tank - 2	Tank - 3	Tank - 4	Tank - 5	None	
Reason of Model Selection	It has Multiple Purposes	Count	6	6	2	6	5	0	25
		% of Total	11.3%	11.3%	3.8%	11.3%	9.4%	.0%	47.2%
	It is Cheap	Count	1	0	0	0	0	0	1
		% of Total	1.9%	.0%	.0%	.0%	.0%	.0%	1.9%
	It is Easy to Set up	Count	2	2	0	0	0	0	4
		% of Total	3.8%	3.8%	.0%	.0%	.0%	.0%	7.5%
	It Requires Little Space	Count	3	7	0	0	0	0	10
		% of Total	5.7%	13.2%	.0%	.0%	.0%	.0%	18.9%
	It is Easy to Maintain	Count	0	3	0	0	0	0	3
		% of Total	.0%	5.7%	.0%	.0%	.0%	.0%	5.7%
	It Helps to Reduce utility Cost	Count	3	1	2	1	0	0	7
		% of Total	5.7%	1.9%	3.8%	1.9%	.0%	.0%	13.2%
	Others	Count	0	1	0	0	1	1	3
		% of Total	.0%	1.9%	.0%	.0%	1.9%	1.9%	5.7%
Total		Count	15	20	4	7	6	1	53
		% of Total	28.3%	37.7%	7.5%	13.2%	11.3%	1.9%	100.0%

Table – 6.23: Cross-tabulation of Reasons of selection of the model and their reason of not installation of tank earlier as because of space problem

			Reasons of Model Selection							Total
			It has Multiple Purposes	It is Cheap	It is Easy to Set up	It Requires Little Space	It is Easy to Maintain	It Helps to Reduce utility Cost	Others	
Space Problem (tank has not been adopted because of space problem)	No	Count	8	0	1	1	3	2	1	16
		% of Total	12.3%	.0%	1.5%	1.5%	4.6%	3.1%	1.5%	24.6%
	Yes	Count	25	1	3	9	1	8	2	49
		% of Total	38.5%	1.5%	4.6%	13.8%	1.5%	12.3%	3.1%	75.4%
Total		Count	33	1	4	10	4	10	3	65
		% of Total	50.8%	1.5%	6.2%	15.4%	6.2%	15.4%	4.6%	100.0%

Table – 6.24: Cross-tabulation of Reasons of selection of the model and their reason of not installation of tank earlier as because it is considered as expensive

			Reasons of Model Selection							Total
			It has Multiple Purposes	It is Cheap	It is Easy to Set up	It Requires Little Space	It is Easy to Maintain	It Helps to Reduce utility Cost	Others	
Expensive (Tank has not adopted earlier because it is expensive)	No	Count	25	0	2	9	3	5	2	46
		% of Total	38.5%	.0%	3.1%	13.8%	4.6%	7.7%	3.1%	70.8%
	Yes	Count	8	1	2	1	1	5	1	19
		% of Total	12.3%	1.5%	3.1%	1.5%	1.5%	7.7%	1.5%	29.2%
Total		Count	33	1	4	10	4	10	3	65
		% of Total	50.8%	1.5%	6.2%	15.4%	6.2%	15.4%	4.6%	100.0%

Findings from Case-study - 2

The study on the non-adopters of tank in the Sumida City shows that the innovative technology, rainwater tank, is not only quite known to the community members but also they recognized it is an effective technology. However, two different factors including space problem and expensiveness of tank installation have been identified as major problems of tank installation. It is found that in order to promote the technology at wider level, the utility or purposes of rainwater tank must been widen. People prefer to get multiple use of water from the tank, however, they have space problem to install the tank and also a group of individuals think that the tank installation cost is high. In this study, the respondents have been providing information about various types of household rainwater tanks. Based on the study findings, it can be argued that all types of tank are unable to meet up beneficiaries demand and personal requirements. The purposes that can be served by the rainwater harvesting tank at household level are limited at – gardening, cleaning and some extent it can be an effective device for fire fighting, though has not been tested yet. In nutshell, if the tank serves multiple purposes, it may motivate the individual to adopt the tank; however, the tank design should consider the lack of space.

6.4 Conclusions and Policy Implication

The present study focuses on two areas in respect of water related risks and the development and dissemination of prevention measures of such risks. In case of Bangladesh, the community is under the threat of getting pure drinking water due to arsenic and water salinity problems, and there is lack of infrastructural measures initiated by the local government or other organization. There is an urgent need to provide an alternative drinking water supply in order to prevent and reduce such risks. In case of Sumida, Japan, a lot investments have been made in water related infrastructure and as a result the local community enjoys an effective and better quality of water. However, direct and indirect impacts generated through water management policy like dam construction for water supply in upstream areas, displacement of upstream community, lack of urban flood control measures have not been addressed. Theses potential risks may challenge the local community in future and also such adverse impact can spread at more regional level. Therefore, a pro-active measure needs to be taken in order to prevent such risks.

Water harvesting technology, particularly at household level, has been considered as a potential mechanism to fight with water related risks in both the areas, though the purpose of using water is different. It has been found that the local communities both in Japan and Bangladesh regard the technology or innovative idea as an effective technological device to address the above mentioned issues in the respective regions. In both regions, the technology has been adopted by a particular group of individuals. In case of Bangladesh, a section of affluent individuals adopted the tank and the tank is still unreachable for the poor people. Whereas, in case of Japan, the tanks have been adopted due to some particular personal reasons and any common motives did not derive the tank dissemination process. In Bangladesh, Tank installation by the early adopters helped the dissemination of tank among others through social networks, though the dissimilation is restricted among the affluent people. In Sumida, mass media played the more efficient and effective role than the social network, though the social network is not absolutely absent. The role of social network is very effective in the context of Bangladesh, particularly because the people do not have much access to mass media like TV, newspaper and internet and also education dis-advancement makes it more challenging to become aware about the progress of new technologies.

Simultaneously, social networks work as a social influence and social pressures to others. It has been found apart from a few group of individuals who do not know about the tank or relatively have not much water problem, all of the respondents are motivated to adopt the tank. However, two measure factors have been identified behind not installation of tank - a) lack of financial capacity and b) lack of proper knowledge and awareness like "how to do it", "level of awareness about the water related risks". Though, the affordable amount is strongly correlated with the economic capacity of the individuals, but this is not only the one deterministic factor. For example, higher income group individuals may not be always willing to pay more money for tank installation as because they did not realize the importance of the technology or not aware about the existing water risks fully. In particular, three types of group of individuals are identified in respect of tank installation and affordable cost of tank installation –

1) Group one is comprised by economically well-to-do individuals whose can afford a large portion of the tank installation cost, however, a section of them don't like to invest much as their level of education and level of awareness is low.

2) A middle income group of individuals who can share the moderate level of cost of the tank.

3) This group is comprised by the extremely poor people who are engaged in the informal sectors and have lack of education and lack of resources, can only afford a very limited amount of money for tank installation.

To address such issues hindering the tank dissemination process, the potential measures or strategy could like as follows –

1) Effective exploitation of social networks is required in order to make the community become motivated and aware of the technology. Social network can work as a social pressure and social influence on the individuals. Example – social learning and social influence may motivate an individual to invest more money for tank installation, or presence of tank at popular place such as market place is found as an effective source of learning for a greater number of individuals about the presence of the tank.

2) Using indigenous knowledge and local labor force may reduce the tank installation cost and as a result a greater number of individuals can afford the cost of tank installation.

3) Cross-subsidy can be introduced by getting profit through selling it in higher price among the affluent people and distribute the profit as incentives to the poor people.

Rainwater harvesting movement in Bangladesh is although strict at household level or more at micro level. The implementation of such technology is not attempted at broader scale like using public building such as school building, administrative buildings etc. in the locality. A collaborative approach between the local Government and NGOs and NPOs are required in order to enhance such measurement at wider scale. Rainwater harvesting at wider scale may help the all section of the community to have the access of such facility and also it may work as a knowledge creation mechanism.

The study on the non-adopters of tank in the Sumida City shows that in order to promote the technology at wider level, the utility or purposes of rainwater tank must been widen.

The presently available rainwater tanks are unable to meet up beneficiaries demand and personal requirements. The rainwater harvesting technology does not become a complementary or alternative water supply because of two reasons – the community has an efficient water supply provided by the local government and on the other hand rainwater harvesting at household level has very limited uses and also the quality of water is not very certain. The purposes that can be served by the rainwater harvesting tank at household level are limited, rather it works as a as a symbolic device to fight with future environmental risks. However, to address the public interest of the community, the technology practicing at household level may not be an answer. The issues like reducing pressure on sewage system and urban flood control through practicing in-situ rainwater collection at wider level may not be implemented by practicing rainwater harvesting at single household level. The potential threats towards such practice at household level are – the technology is expensive, space problem for tank installation, unwillingness of household members as because they have alternative efficient water supply. The Sumida city has already tested the technology at wider scale in the public building like 'Sumo stadium' or 'Sumida city office building' which show that rainwater harvesting at wider scale can stand as an alternative water supply by providing facilities like flashing toilets and other multifarious non-drinking purposes. Such macro or meso level practice not only increase the utilities of the beneficiaries, but also it is an effective mechanism to address the public interests of the community like flood control. Similarly it induces the sense making process among community, like the existence of such giant alternative water supply system makes the local community becomes aware of the effective water management to fight with future risks. Therefore, in order to promote the mechanism at private building level, the scaling up of the mechanism may be inevitable. Since the study shows that there are space problem of tank installation and the technology is too costly to afford by the individual house, an alternative potential approach could be practicing rainwater harvesting by a sharing or utilizing public or semi-public areas by a group of houses or also practicing rainwater harvesting in group houses or housing complex . Colleting rainwater at bigger places or storage space may also make it possible to use rainwater for more multifarious purposes and also help to solve more concrete or actual risks of the community.

Chapter – 7: Conclusions

The research has primarily focused on modeling and analyzing of the rainwater harvesting technology dissemination process in order to develop the adaptive management plan for the areas under water related risks; the major focus is placed on the role of social network development process. Three different but mutually complementary scopes have been addressed in the thesis –

1) A microscopic perspective of social network development process among the anonymous individuals in the technology dissemination process.
2) The role of the key players and their network formation in an innovation dissemination process
3) Adaptive management plan for the social implementation of rainwater harvesting technology

7.1 Main Contribution

Chapter 1 has described the overview and background of this research including the aim and the organization of the thesis.

Chapter 2 focuses on literature reviews on the importance of social implementation of technology, particularly in disaster risk management context. In this chapter broadly two types of social network approaches have been mentioned. The first approach focuses more on the network among anonymous individuals or adopters. It has been found that to examine the impact of social pressure and social influence on the adopters, the social networks may be taken into consideration both at adopter's personal level and also at his or her community level. Individual may be influenced by both of the social networks. Literature reviews show that three types of information are required for adopters to reduce the uncertainty of adoption decision. Individuals may receive all types of information from various sources like social network groups, economic groups and also from their cultural groups. Therefore, it is instrumental to examine the pattern of three types of information sharing activities and also to examine who are adopter's social referents or sources of information to acquire which kind of information. At the end, an alternative approach of social networks shows the necessity of examining the network development process among the key players of an organization in order to find out constrains and opportunities of the organization to bring the innovative idea from the innovator to the end users.

Chapter 3 deals with the rainwater harvesting technology dissemination process in the coastal areas of Bangladesh. By using the social network threshold model, the study has specified the adopter's degree of innovativeness in respect of regional level and personal or neighborhood network level that may help to understand the macro and micro level social network impacts on rainwater tank adopters in the arsenic prone coastal Bangladesh. The study shows that in the rural areas of Morrelganj Upazila, once the tanks have been installed in one village, the tank has not disseminated in the same village. It seems that tank installation by few individuals motivated a group of individuals in the village, but since the NGO pull out the programme, no more tanks were installed in those remote villages. In case of Morrelganj town, in the initial phase of the diffusion of rainwater tank, the adopters sparsely distributed in various neighborhoods and as a result their tank adoption did not influence or motivate others individuals initially and also social network formation among the adopters was low. In the later phase, personal or

neighborhood social networks, developed through direct social and spatial interaction, helped the individuals not only become exposed to the innovation, but such personal or neighborhood level network formation created social pressure on non-adopters. Ultimately it helped to render the rainwater tank adoption process. Social system, on the other hand, may well serve as a platform for social support and learning for individuals in tank dissemination process. The study on the rural areas of Chetalmari Upazila shows that the tank dissemination in those villages is dispersed and skewed. Though the initial development of tank dissemination was quite high, the tank adoption almost stopped for a certain period and again it started to disseminate in the last phase. In the last phase, adoption not only concentrated in some particular villages, but it also started to diffuse in other surrounding villages. It seems that tank adoption by few individuals not only influences their own co-villagers, but also an inter-village information sharing networks have been developed in the later phase of the diffusion. External influence on the adoption decision behavior has not been found to be so significant in all areas. This finding indicates that in a small town or villages, mass media has very negligible role or impact on the diffusion of innovation. However, it is important to note that the tank dissemination is limited or concentrated among the socially economically affluent group of individuals in almost all the study areas. Therefore, the choice of rainwater harvesting technology may be limited within a particular group of community members.

Chapter 4 concentrated on information sharing activities in the various phases of tank dissemination process in Coastal Bangladesh. The direction, pattern, density of three types of information sharing activities – hearing, observation, discussion have been examined to know that role of each information on adopter's decision making process. There is almost no role of mass media in tank dissemination process in both rural and urban areas of areas of Morrelganj Upazila, whereas mass media may have a moderate role in the early phase of the tank diffusion process in the rural areas of Chetalmari Upazila (sub-district). In the rural areas of both Upazilas (sub-district), awareness campaign organized by the NGO provided a general idea of the tank to all section of individuals in those villages. However, knowing from NGO worker only a few groups of individuals have adopted the tank. In the next phase, observing their tanks and discussing with the early adopters, another group of individuals become certain about the effectiveness of the tank and become motivated to install it. As a result, social networks of observation and discussion are quite highly dense in those regions. Villages which are physically closely located, social networks have established among the members of those villages. Physical proximity induced social contagion. A different scenario is found in case of urban area, Morrelganj town. Apart from the NGO workers' campaign, the information of tank has also diffused through the community members from mouth to mouth. As a result, not only observation and discussion, but also social network of hearing is quite dense in Morrelganj town. However, information was not passed by all of the innovators in respect of the whole region; but the individuals may have received information from their respective neighborhoods' innovators. It is also found that in the initial phase, a group of innovators directly informed about the rainwater tank to the selected number of individuals and afterward through the initiative of late adopters, information diffused indirectly among the individuals at a wider scale.

Social network of hearing and discussion shows that the adoption process is dispersed or unsteady where the social network ties are inadequate; the adaptation rate is steady and balanced in those neighborhoods where there is a prominent social network. Such

connotation can not be found in case of observation network. The temporal dimension of social networks of hearing along with the spatial dimension can also be found in the present study. The result shows that social networks do exist for certain period of time, and afterward again new social network emerged, particularly in case of hearing and discussion. Information sharing activities are not closed within the economic group, but adopters' hearing and discussion networks are more closed within their cultural, spatial and social network groups. Individuals heard about the tank mostly from their cohesive group members and also a same trend has been found in case of discussion. So higher the informal network among the adopters, it encouraged their information sharing activities irrespective of their occupation, religion, income and neighborhood. Individuals observed the tank mostly from their neighborhood partners. Therefore, a correlation has been found between observation and geographical location.

Chapter 5 deals with rainwater harvesting movement in the Sumida Ward, Tokyo. In the first section, the focus has been given on social networks among the key players of rainwater tank dissemination process in order to under understand the structure of the organization which fosters the dissemination of innovation. Three players including comrades, appreciators and circulators took a key role in this process. In the initial phase, the role of comrade and appreciator and their network formation with the inventor helped to trail the technology. Circulator appeared in the post-trail phase and disseminated the message inside and outside the region. The network development of appreciators and comrades helped mainly the local community to take the fruits of innovation, whereas circulator helped both the local community as well as the imitators to cultivate the technology at a wider level and get benefited out of it. As the dissemination progressed, more and more players appeared into scenario and dense networks have been established among the players, which helped to disseminate the innovation from inventor to the end users.

Information about the rainwater tank among the end users did not flow through interpersonal connection; rather adopters received information from the mass media, Moreover, adopters neither observed neighbors' tank, nor they discussed about the tank with any of their social network partners. Social networks did not develop in the first phase of the diffusion. However, those who adopted the tank, a good number of them passed information to the non-adopters, particularly to their neighbors. Therefore, social networks of information sharing started to develop in the second phase of the technology dissemination process, i.e., after a few individuals adopted it. But this social network could not trigger the technology dissemination process. The study has identified two main reasons behind the ineptitude of social networks - First, attributes of the innovation or rainwater harvesting tank needs to be improved, particularly use of rainwater tank needs to be widen. Second, since a segregated group of individuals have been adopted the tank, their adoption has not created any social influence or social pressure to the other members of the community and similarly it does not become a source of learning for them.

Chapter 6 broadly deals with issues that need to be taken into consideration in order to develop an adaptive management plan for the rainwater harvesting practice in both these regions. Water harvesting technology, particularly at household level, has been considered as a potential mechanism to fight with water related risks in both the areas, though the purpose of using water is different. It has been found that the local communities both in Japan and Bangladesh regarded the technology or innovative idea as an effective technological device to address the above mentioned issues in the

respective regions. However, in both regions, the technology has been adopted by a particular group of individuals. In Bangladesh, Tank installation by the early adopters helped the dissemination of tank among others through social networks, though the dissimilation is restricted among the affluent people. In Sumida, mass media played more efficient and effective role than the social network, though the social network is not absolutely absent.

In case of Bangladesh, apart from a few groups of individuals who do not know about the tank, all of the respondents are motivated to adopt the tank. However, two measure factors have been identified behind not installation of tank - a) lack of financial capacity and b) lack of proper knowledge and awareness like "how to do it", "level of awareness about the water related risks". Though, the affordable amount is strongly correlated with the economic capacity of the individuals, but not only the one deterministic factor. In particular, three types of group of individuals are identified in respect of tank installation and affordable cost of tank installation – 1) Group one is comprised by economically well-to-do individuals who can afford a large portion of the tank installation cost, however, a section of them don't like to invest much as their level of education and level of awareness is low. 2) A middle income group of individuals who can share the moderate level of cost of the tank. 3) This group is comprised by the extremely poor people who are engaged in the informal sectors and have lack of education and lack of resources, can only afford a very limited amount of money for tank installation. Addressing such issues hindering the tank dissemination process, the potential measures or strategies have been recommended – a) Effective exploitation of social networks is required in order to make the community become motivated and aware of the technology; b) Using indigenous knowledge and local labor force to reduce the tank installation cost ; c) Cross-subsidy between rich and poor can be introduced by getting profit through selling it in higher price among the affluent people and distribute the profit as incentives to the poor people; d) Rainwater harvesting at wider scale like public building may help the all section of the community to have the access of such facility.

The study on the non-adopters of tank in the Sumida City shows that in order to promote the technology at wider level, the utility or purposes of rainwater tank must been widen. The purposes that can be served by the rainwater harvesting tank at household level are limited, rather it works as a as a symbolic device to fight with future environmental risks. However, to address the public interest of the community, the technology practicing at household level may not be an answer. The issues like reducing pressure on sewage system and urban flood control through practicing in-situ rainwater collection at wider level may not be implemented by practicing rainwater harvesting at single household level. The potential threats towards such practice at household level are – the technology is expensive, space problem for tank installation, unwillingness of household members as because they have alternative efficient water supply. The Sumida city has already tested the technology at wider scale in the public building like 'Sumo stadium' or 'Sumida city office building' which show that rainwater harvesting at wider scale can stand as an alternative water supply by providing facilities like flashing toilets and other multifarious non-drinking purposes. Such macro or meso level practice not only increase the utilities of the beneficiaries, but also it is an effective mechanism to address the public interests of the community like flood control. Similarly it induces the sense making process among community. Therefore, in order to promote the mechanism at private building level, the scaling up of the mechanism may be inevitable. Since the study shows that there are space problem of tank installation and the technology is too

costly to afford by the individuals house, an alternative potential approach could be practicing rainwater harvesting by a sharing or utilizing public or semi-public areas by a group of houses or also practicing rainwater harvesting in group houses or housing complex . Colleting rainwater at bigger places or storage space may also make it possible to use rainwater for more multifarious purposes and also help to solve more concrete or actual risks of the community.

Chapter 7 summarizes the main contributions of the research and refers to the needs for further extensions of this research

7.2 Future Research

The future research on social implementation of rainwater harvesting technology should focus on -

1) The study has assumed that each community is homogeneous with respect to adoption by households with little difference in income, educational attainment, and exposure to mass media. Future research should be conducted among more heterogeneous group of individuals having differential choices and socio-economic capacities in order to understand more dynamic aspect social network development.

2) The present study discussed about three types of information sharing activities and social network development process. In future, continued attempt should be made to find out what types of social networks or information sharing activities influence adopters' decision making process and how?

3) The present study focuses the scope of rainwater harvesting practice at household level. In order to promote the technology, the practicing of such technology at community level may also be important as the study indicates. Therefore, a further research must be conducted in details on the scope of rainwater harvesting practice at community level.

4) In case of Bangladesh, micro credit system has been introduced to promote rainwater harvesting technology among the economically weaker section of the people. In future, further attempts must be made to examine the effectiveness and sustainability of micro-credit schemes so that the rainwater harvesting technology can be provided to poor people in developing countries.

Appendix – 1

Questionnaire Survey of Rainwater Tank Adopter in the Coastal Bangladesh

SL No … ……

Name	

Father's / Husband's Name	

Address	**Ward No/ Area name(Para)**	**Municipality/ Union**	**Sub-district**	**District**

Demographic Characteristics			
Age	**Sex**	**Education Level**	**Period of Staying in the area**

Household Characteristics				
Family Type	**Household size**	**No. of Children below 10 years in the household**	**No. of Female in the Household**	**No. of male in the Household**
Remarks				

Occupation and Income					
Primary Occupation	**Secondary Occupation**	**No. of Earning members in Household**	**Total household income (in Taka)**	**Agricultural land**	**Livestock**
Remarks					

Cosmopolitan Nature				
Mobile	**TV**	**Do you read Newspaper everyday**	**Do you watch TV**	**How often do you go to Big City**

Housing Characteristics			
Ownership	**Building materials**	**Age of House**	**Built up area**
	Roof : **Wall** : **Floor** :		

Water Requirements / Day (in Liters)			
Drinking and Cooking	**Bathing and Sanitary**	**Other Purpose (Washing, Cleaning)**	**Total water Requirement**

Sources of Water	**Sources of Water at Present**	**Before rainwater tank, which water were you drinking?**
Remarks		

Rainwater Usages	
What is the main use of rainwater	
What kind of water treatment did you make when rainwater were not used/ installed	
Did you face any problem due to using this water earlier	
Advantages of Rainwater	
What mode do you think is the best method to collect rainwater	

Quantitative Study	
How long did the tank rainwater serve as drinking water in within one year?	
During which month do you face water deficit in your tank	
What did you do when the tank water was used up?	
Is the present tank capacity adequate to go through the dry season?	
If inadequate, what capacity is required?	

Qualitative Study				
Do you face any problem with rainwater	**Taste of the rainwater in the tank?**	**Do you detect coloring**	**Do you detect odor**	**Do you detect particles/muddiness**

Tank	
Time of tank Installation	
Type	
Capacity	
Height	

Work Period and laborers	
Work of Period for the installation of the rainwater utilization facility	
Number of workers involved in the installation work	
Plaster	……persons X ……Days
Assistance	……Persons X ……Days

Structure of Rainwater Tank				
ROOF				
How many roof is the rainwater collected from	**Which part of the roofs is the rainwater collected**	**Areas in which rainwater is collected**	**Roof material**	
GUTTERS				
Gutter materials	**Length of Horizontal gutter**	**Length of Vertical gutter**	**If there is no vertical gutter, how does the rainwater flow into the tank**	**Please write how the vertical gutter, if any is connected to the tank (please describe specifically)**
INLET				
Distance from the ground				
Is there a net cover on the inlet of the tank				
FAUCET				

Distance from the ground	
Is there a locking device	
Are cut pipes for collecting rainwater at the initial stage	
DRAIN	
Distance from the ground	
Is there a net cover on the overflow outlet	
OVERFLOW	
Distance from the ground	
Is there a net cover on the overflow outlet	
WATER LEVEL INDICATOR	
Is there a water level indicator	
If there is no water level indicator, how do you know the amount of water stored	
COVER MATERIAL	
How well is the opening of he concrete ring sealed by the cover – is there any space between the ring and the cover?	
Does the cover completely cover the opening of the concrete tank	
Does any gap exist that will allow insects to enter	

State of use of the facility

Are there any tree leaves over the roof?	
Is there trash in the gutter?	
Is there trash such as dead leaves at the inlet?	
Is the drain for collecting rainwater at the initial stage open or closed on a fine day	

Management and Maintenance	
Do you prune trees so that they will not cover the roof (s)?	
Do you clean the roof	
Do you clean the Horizontal gutter(s)	
Do you remove the residue in the tank, using the drain?	
Is the inside of the tank cleaned	
Is there a ladder to go up to the roof	

Things you specifically keep in mind when managing the facility	
Things that worry you when managing the facility	

Please write freely things you have noticed concerning the management and other aspects of the facility

Financial Aspect (Micro- Credit)	
Installation cost	
How did you pay the tank installation cost?	
Did you borrow the entire amount or part of the cost?	
How much did you borrow?	
How many months did it take to pay back the loan	
How much did you pay per month?	
What do you think is a reasonable maximum amount to pay back per month?	

Time of information	
Can you remember when you first heard/knew about rainwater tank?	
Reason of late/ early installation after hearing	
Please mention the sources from where you first hared/knew about rainwater tank	
Which of the sources you think influenced you most to install rainwater tank?	
With whom have you discussed about rainwater tank before installation	

Social Networks

Knowing about rainwater tank

Can you please name us 3 individuals from whom you have first time heard about water harvesting tank?

	Name	Age	Sex	occupation	Relation	Rainwater tank adopted	Date/ time of adopting rainwater tank
1							….. …….Y ……...M
2							….. …….Y ……...M
3							….. …….Y ……...M

Observation of Rainwater tank

Have you observed rainwater tank before installation?
Can you name us three persons (house) where you first observed rainwater tank?

	Name	Age	Sex	occupation	Relation	Home	Date/ time of adopting rainwater tank
1							
2							
3							

Discussion about rainwater tank

Can you please name us 3 individuals with whom you have discuss about rainwater tank (Before or After tank installation) -

	Name	Age	Sex	Occupation	Relation	Rainwater tank adopted	Date/ time of adopting rainwater tank
1							
2							
3							
Remarks							

Discussion about arsenic

Have you discussed about arsenic problem with anyone	
Have you ever seen arsenic patient?	
Have you ever seen any programme or report on arsenic on TV or News Paper	
Have you ever attended any meeting or conference on arsenic problem	

Informal Social Networks (General)

Can you name us three tank adopters with whom you often turn for advice, suggestion and discussion in daily life -

	Name	Age	Sex	occupation	Relation	Home	Date/ time of adopting rainwater tank
1							
2							
3							
Remarks							

Main reason of Installation
1) 2) 3)

Remarks:

Appendix – 2
雨水利用貯水槽に関する聞き取り調査

実施日時：　　年　　月　　日
実施者氏名：

１．　あなた自身とお住まいについてお聞きします

1.1　あなた自身についてお聞きします

(1)　お名前（＿＿＿＿＿＿＿＿＿＿＿＿）

(2)　住所

（＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿）

(3)　年齢

a. 30 歳未満	b. 30 歳以上~40 歳未満	c. 40 歳以上~50 歳未満
d. 50 歳以上~60 歳未満	e. 60 歳以上~70 歳未満	f. 70 歳以上~40 歳未満

(4)　性別

1. 男性	2. 女性

(5)　世帯人数　　あなたを含めて　（＿＿＿＿＿＿）人

(6)　小中学生のお子さんが家族にいますか　　a. はい　　b. いいえ

(7)　車を所有していますか　　a. はい　　b. いいえ

(8)　あなたとあなたの家族は、地域活動をしていますか。あてはまるもの全てにお答え下さい

a. 自治会	b. 婦人会	c. 民生委員	d. 自主防災会	e. 子ども会
f. 老人会	g. 青年団	h. 消防団	i. 地域の掃除	
j. その他(				

(9)　あなたは「路地尊」を知っていますか　a. 知っている　　b. 知らない

(10)　あなたは「路地尊」の作成に関わりましたか　a. 関わった　b. 関わっていない

1.2　あなたのお住まいについてお聞きします。

(1)　あなたのお住まい

1. 一戸建てで　＿＿＿＿階建ての家に住んでいる
2. 集合住宅で　＿＿＿＿階建ての＿＿階に住んでいる

(2)　あなたのお住まい

1. 持ち家	2. 賃貸

(3)　あなたのお住まいの構造

1. 木造	2. 非木造(鉄筋や鉄骨造りなど)

(4)　あなたのお住まいには屋上がありますか　　a. はい　　b. いいえ

(5)　あなたのお住まいには庭がありますか　　a. はい　　b. いいえ

(6)　あなたのお住まいには打ち水をする場所がありますか　a. はい　　b. いいえ

(7)　あなたは、現在の場所におよそ何年間住んでいらっしゃいますか。

1．1 年未満	2．1 年以上 3 年未満	3．3 年以上 10 年未満
4．10 年以上 20 年未満	5．20 年以上 30 年未満	6．30 年以上 40 年未満
7．40 年以上 50 年未満	8．50 年以上	

２．　ご自宅の貯水槽に関してお聞きします

１）設置容量	a.200L タイプ　b.250L タイプ c.その他（　　）
２）設置費用	a.52,500 円　b.63,000 円　c.66,150 円 d.その他（　　）
４）墨田区の補助金を利用したか	a.利用した　b.利用していない
３）設置時期	年　　月　　日ごろ
４）ろ過装置を装着しているか	a.つけている　b.つけていない
４）貯水槽の主な用途 （複数回答可）	1) 飲料水 2)料理 3) 清掃 4) 洗濯 5) 家庭菜園 6) 植栽への水やり 7)道路への水まき　8)洗車 9)その他（
５）貯水槽の容量	a.余るぐらい　b. ちょうどいい　c.足りない
６）水質	a.良い　b. 悪い　c.どちらでもない
７）貯水槽のデザイン	a.良い　b. 悪い　c.どちらでもない
８）貯水槽に満足していますか？ （ひとつだけお答えください．）	1) 非常に満足している 2) 満足している 3) どちらでもない 4) 満足していない

３．貯水槽を設置するにあたり、決めてとなった理由はどれですか。ひとつだけお答えください。

1) きれいな水を得るため
2) 災害時の消火等に役立てるため
3) 水道代削減のため
4) 節水対策のため
5) 渇水対策のため
6) 環境に配慮するため

7) 友人や隣人が使っていていたから
8) 友人や隣人に促されたため
9) 街中で設置されているのを見て
10) 製作者のことを知っていたから
11) 墨田市に勧められたため
12) 墨田市の補助金が使用できるため
13) その他

４.貯水槽の設置に要した日数についてお聞きします。

1) 貯水槽のことを聞いてから導入するまで，何日かかりましたか？ ＿＿＿＿日ぐらい
2) 日数がかかった理由は何でしたか

1. 費用調達のため	2. 貯水槽の性能に関して調べるため
3. 設置場所を整理するため	4. 補助金の申請の仕方を調べるため
5. 他の業者の製品と見比べるため	6. 他の人に使用具合を尋ねるため
7. その他（	

５．実際に貯水槽を利用して感じた一番大きな利点はどれですか。 ひとつだけお答えください。

1) 水道代が削減できる
2) 設置に補助が得られる
3) きれいな水が得られる
4) 災害時の消火等に役立てられる
5) 環境に配慮できる
6) 雨水に対する考えが変わった
7) その他

６．実際に貯水槽を利用して感じた一番大きな欠点はどれですか。 ひとつだけお答えください。

1) 高額である

2) 水質が良くない
3) 容量が十分でない
4) デザインがよくない
5) 維持管理が大変である
6) そうじがしにくい
7) 場所を取る
8) その他

７．貯水槽を他の人に教えましたか・教えたいと思いますか。

a.すでに他の人に教えた（　　人）　b.教えたい　c.教えたくない　d.考えていない

８．あなたが貯水槽を設置する前に、貯水槽についての話を聞いた方（あなたに教えてくれた方）の家の場所を地図にマークしてください。多くいるのであれば最大３人まで(２人か１人でも結構です)お答えください。（差し支えなければ，お名前もお教えください）

	お名前	住所	あなたとの関係 （ひとつ選択）	その人の家には、貯水槽が設置されていますか
1		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後
2		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

3		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

９．あなたが貯水槽を設置する前に、貯水槽が設置されているのを見た家の場所を地図にマークしてください。多くいるのであれば最大３件まで(2 件か 1 件でも結構です)までお答えください。（差し支えなければ，持ち主のお名前もお教えください）

	お名前	住所	あなたとの関係 （ひとつ選択）	その人の家には、貯水槽が設置されていますか
1		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後
2		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

3		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

１０．あなたが貯水槽を設置した後に、貯水槽についての話をした人の家の場所を地図にマークしてください。多くいるのであれば最大３人まで(2 人か 1 人でも結構です)お答えください。（差し支えなければ，持ち主のお名前もお教えください）

	お名前	住所	あなたとの関係 （ひとつ選択）	その人の家には、貯水槽が設置されていますか
1		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後
2		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

			9) その他	
3		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

１１．近所で貯水槽を設置している方で、あなたが日常的に最もよく話しをする方の家の場所を地図にマークしてください。多くいるのであれば最大３人まで(2 人か 1 人でも結構です)お答えください。(差し支えなければ，持ち主のお名前もお教えください)

	お名前	住所	あなたとの関係 （ひとつ選択）	その人の家には、貯水槽が設置されていますか
1		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後
2		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。

			7) 墨田市 8) 他の地区の行政職員 9) その他	a.前　b. 後
3		周辺の地名 区 市	1) 友人 2) 親戚 3) 隣人 4) 同僚 5) 知人 6) NPO 職員 7) 墨田市 8) 他の地区の行政職員 9) その他	a.はい　b. いいえ 「はい」の場合 その人が貯水槽を設置したのは、あなたが設置する前ですか、後ですか。 a.前　b. 後

１２．あなたが今から貯水槽の設置を検討するとしたら、以下のメディアのうちどれが一番参考になると思いますか？参考になる順に番号をつけてください。

	墨田市役所による広報		NPO のメンバーの話など
	テレビ		インターネット
	新聞		友人知人
	その他 （　　）		

以上で終了です。ありがとうございました。

Appendix - 3
アンケート 回答用紙

（世帯主の方を対象にした調査です）

I.

あなたの家、およびご家族についてお聞かせください。
選択肢のうち、あてはまるものにひとつ、〇をつけてください。
5)、6)は、数字をお書き下さい。

1. あなたは、何人家族ですか？
a) 単身　b) 2 人　c) 3 人　d) 4 人　e)5 人以上

2. あなたの家は、持ち家ですか？　賃貸ですか？
a) 持ち家　b) 賃貸

3. あなたの家の屋根は、どのような材質ですか？
a) 瓦　b) コンクリート　c) ブリキ　d)その他　e) わからない

4. あなたの家は、何階建てですか？
a) 平家　b) 2 階建て　c) 3 階建て　d) 4 階建て以上

5. あなたの家は、築何年になりますか？
おおよそ（　　）年

6. あなたの家の建坪は、どのくらいですか？
（どちらか一方でもけっこうです）
（　　）平方メートル　(　　坪)

7. あなたの家の敷地には、庭や芝生がありますか？
a) はい　b) いいえ

II.

墨田区では、区役所などの主導のもと、雨水がさまざまな大きさの
タンクに集められ、溜められています。また、溜められた水は,
さまざまな用途に使われています。
これは、墨田区の防災や水問題への対処に役立つと考えられています。

以下の問いに対して、当てはまるものにひとつ、〇をつけて下さい。

1. 雨水タンクのことを、何人の方から聞いたことがありますか？
1) 誰からも聞いたことはない　2) 1 人　3) 2 人　4) 3 人以上

2. 今までに、何ヶ所で雨水タンクを見たことがありますか？
（路地尊、墨田区庁舎など公共の雨水タンクは除きます。）
1) 見たことはない　2)1 ヶ所　3) 2 ヶ所　4) 3 ヶ所以上

3. 雨水タンクを導入しない理由は、何かおありですか？
あなたの考えをお聞かせ下さい。
（この問題は、複数選択していただいてもけっこうです。
2 つ以上の項目を選択されるときは、最も大きな理由と思う項目の後ろのカッコの中に〇を記入して下さい。）

1) いままで知らなかったから　（　）
2) よくわからない物だから　（　）
3) 役に立つとは思えないから　（　）
4) 高価だから　（　）
5) 水道水が使えるから　（　）
6) 設置する場所がないから　（　）
7) 扱うのが難しい（難しそうだ）から　（　）
8) アドバイスや相談に乗ってくれる人がいないから　（　）
9) 個人（世帯）レベルで導入できるとは思えないから（　）
10) 雨水は汚れていると思うから　（　）
11) 虫がわきそうだから　（　）
12) デザインが良くないから　（　）
13) その他（具体的にご記入下さい。）　（　）
(　　)

4. 雨水タンクは、水問題に対してどのように役立つとお考えですか？
(複数選択していただいても結構です)

1) これまで活用されていなかったが、 水道の補助的な水源として
活用できる
2) 環境保全に実際に役立つ
3) 防災に実際に役立つ
（例：消火、地震後の生活用水、洪水災害の軽減）
4) 自然の資源を有効に活用できる
5) 水道料金を実際に節約できる
6) 実際にそれほど役に立つとは思えないが、環境保全や防災、
資源活用の運動を盛り上げるキャンペーン効果はある
7) 役にはたたない

5. 雨水利用という技術に対して、どのようなイメージをもっておられますか？

1) 非常に良い　2) 良い　3) 良いとも悪いともいえない
4)悪い　5) 非常に悪い

6.「路地尊」をご存知ですか？

1) はい　2) いいえ

7. 今まで、路地尊や、墨田区庁舎の雨水利用システムなど、公的な雨水利用システムをご覧になったことがありますか？

1) はい　2) いいえ

8. 雨水利用の取り組みは、政府によって推進されるべきだと思われますか？

1) はい　2) いいえ

III.

6 ページ~～8 ページに、雨水タンクの例が *5 種類*、記載されています。価格、容量、外観などは、それぞれのタンクの絵の横に記載されています。
それぞれの雨水タンクについて、あなたのご意見をお聞かせください。

1. 5種類のモデルのうち、どのモデルが一番よいと思われますか？
当てはまるものにひとつ、〇をつけてください。

1)モデル１　2)モデル２　3)モデル３　4)モデル４　5)モデル５
6)どれも良いと思わない

2. 1)でお答えの理由は何ですか？
当てはまるものにひとつ、〇をつけてください。

1) 溜めた水を、様々な用途に使うことができるから
2) 安価だから
3) タンクの設置が簡単だから
4) 場所をとらないから
5) タンクの維持が簡単だから
6) 水道代が節約できるから
7) タンクのデザインがいいから
8) その他 （　　）

3. もしあなたが、他の誰か（友人など）に雨水タンクの設置を勧められた場合、それぞれの雨水タンクについて、どうお考えになりますか？
あなたの考えをお聞かせ下さい。当てはまるものにひとつ、〇をつけて下さい。

	ぜひ設置してみたい		設置を考えてもよい		あまり設置するつもりはない		まったく設置するつもりはない
1)モデル１	4	・	3	・	2	・	1
2)モデル２	4	・	3	・	2	・	1
3)モデル３	4	・	3	・	2	・	1
4)モデル４	4	・	3	・	2	・	1
5)モデル５	4	・	3	・	2	・	1

以上で、質問は終わりです。
ご協力、誠にありがとうございました。

5 種類の雨水タンク

★ モデル１

●容　　量・・・・・110 リットル（バケツ約 10 杯）
●幅・・・・・・・・・・・約 65 センチ
●奥　行　き・・・約 60 センチ
●高　　さ・・・・・約 40 センチ（架台含む）

●タンク価格・・・・・約 36,000 円（架台含む）
※工事費、運搬費が別途必要

●用　　途・・・・・散水、防火用水

★ モデル 2

●容　　量・・・・・250 リットル
（風呂おけ 1 杯と少し）
●直　　径・・・・・約 60 センチ
●高　　さ・・・・・約 120 センチ（架台含む）

●タンク価格・・・・・約 60,000 円（架台含む）
※工事費、運搬費が別途必要

●用　　途・・・・・散水、防火用水

★ モデル 3

●容　　量・・・・・約 500 リットル
（風呂おけ約 2 杯半）
●直　　径・・・・・約 90 センチ
●奥　行　き・・・約 110 センチ
●高　　さ・・・・・約 140 センチ（架台含む）

●タンク価格・・・・・約 160,000 円
（架台、ポンプ含む）
※工事費、運搬費が別途必要

●用　　途・・・・・散水、防火用水、

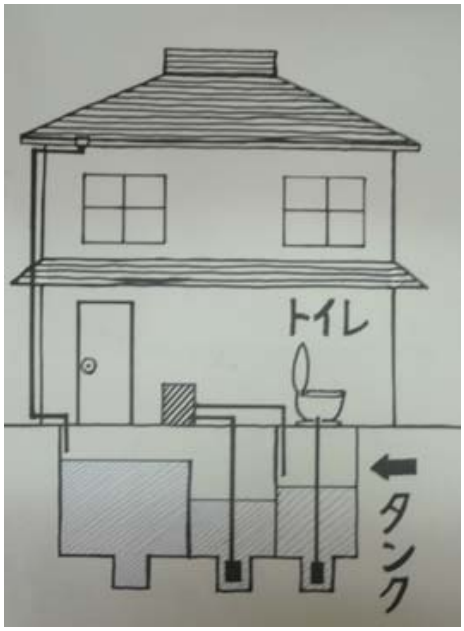
★　モデル４

●容　　量・・・・・約 1,000 リットル
（風呂おけ約 5 杯半）
●幅・・・・・・・・・・約 120 センチ
●奥　行　き・・・約 100 センチ
●高　　さ・・・・・約 150 センチ（架台含む）

●タンク価格・・・・・約 200,000 円
（架台、ポンプ含む）
※工事費、運搬費が別途必要

●用　　途・・・・・散水、防火用水、
災害時生活用水
※トイレに使う場合は、
専用ポンプ（約 8 万円）が別途必要

★　モデル５



※家の基礎（地中梁）に設置するタイプです。

●容　　量・・・・・約 5,000 リットル
（風呂おけ約 25 杯）

●価　　格・・・・・約 50 万円～100 万円

●用　　途・・・・・トイレ、散水、防火用水、
災害時生活用水など

（イメージ）

▼それぞれのタンクは、こんな用途に向いています！！

タンクのモデル（大きさ）	水洗トイレ	散水	洗車	消火用水
モデル１　（110 リットル）	×	○	×	△
モデル２　（250 リットル）	×	○	×	○
モデル３　（500 リットル）	×	○	△	○
モデル４　（1,000 リットル）	△	○	○	○
モデル５　（5,000 リットル）	○	○	○	○

使用水量の目安

貯水タンクに溜めた雨水は、主に水洗トイレや散水、洗車などに利用されています。
日本人１人が１日に使用する水の量は、おおむね以下の通りです。
（なお、バケツ１杯は約 10 リットル、風呂おけ１杯は約 200 リットルです。）

★　水洗トイレ

１回の洗浄あたり、12－20 リットル（従来型）
6－12 リットル（節水型）
家族１人当たり、１日約 50 リットル必要。
例：４人家族で、200 リットルタンクなら**１日分**
1,000 リットルタンクなら**５日分**

★　散水

5 分間ホースで散水・・・・・・・・60 リットル

例：200 リットルタンクなら **3 日分**、
　　1,000 リットルタンクなら **2 週間分**

★　洗車

20 分間流しっぱなし・・・・・・・240 リットル

例：1,000 リットルタンクなら **4 回分**

▼それぞれのタンクは、こんな用途に向いています！！（再掲）

タンクのモデル（大きさ）	水洗トイレ	散水	洗車	消火用水
モデル 1　（110 リットル）	×	○	×	△
モデル 2　（250 リットル）	×	○	×	○
モデル 3　（500 リットル）	×	○	△	○
モデル 4　（1,000 リットル）	△	○	○	○
モデル 5　（5,000 リットル）	○	○	○	○

\

タンクの大きさの目安

水は、1 立方メートル（縦、横、高さが 1 メートル）の入れ物に 1000 リットル入ります。
下に、タンクの大きさの目安を示します。

右のタンクは、**250 リットル**です。
大きさは、直径 60 センチ、
高さ約 120 センチです。
このタンクに満タンの水で、
4 人家族の水洗トイレ 1 日分を
まかなうことができます。

※左下のじょうろと、大きさを
比べてみてください。

右のタンクは、**5,000 リットル**です。
日本では、大きすぎて庭には
置けませんので、家を建てるときに
地下に埋め込む形をとります。
（「地中梁方式」といいます）

ご協力、
誠にありがとうございました。

Appendix – 4
Questionnaire Survey to Find out Affordable Rainwater Tank in Coastal Bangladesh
(Respondent – Non- Adopter of Tank; Study Area – Morrelganj Town)

……

Name –
Address (Neighborhood) –
Age -
Occupation –
Level of education -
Income –

……..
Sources of Drinking Water - a) Pond b) Tube-well (own) c) tube-well(not-own) d) Others

Do you face any problem in your drinking water –
Odor – Yes/ No **Color** – Yes / No **Test** – Yes / No **Health Problem** – Yes / No
Fetching Burden – Yes /No

…….
Do you know about rainwater tank? - Yes / No

Have you ever heard about rainwater tank from anyone? - Yes / No

If yes , kindly name us three persons from whom you have heard about the tank
1) Person – 1……
2) Person – 2 …….
3) Person – 2

Have you ever observed rainwater tank from anyone? - Yes / No
If yes, kindly name us three places where you have observed it
1) ……
2) ……..
3) ……..

……

Do you think rainwater harvesting tank is effective?
a) Very Effective b) Effective c) So-so d) Bad e) Very bad

Have you ever tried to install the tank - Yes / No

Do you like to install rainwater tank
a) Yes b) No c) I have no idea about it

Why did not you install the rainwater tank earlier? (Kindly specify one reason)
a) Expensive b) I have pure water c) I have not proper information d) I was not conscious e) I thought it is not useful f) I don't know how to do it

Why Do you like to install the rainwater tank ? (Kindly specify one reason)
a) To get pure water b) To reduce my water utility cost c) To reduce water fetching problem from outside d) Observing others I am motivated
…….

Do you know about micro-credit loan for rainwater tank installation? – Yes/ No

Do you like to take to tank loan to install rainwater tank? – Yes/ No

If Not, Kindly specify the reason why don't you like to take the loan –

If you are interested to install the tank, how much amount you can afford for the tank installation

……Taka