Aging in Place: Dealing with Breakdown of Welfare Technology

Anita Woll

University of Oslo, Departments of Informatics,

anitwo@ifi.uio.no

Abstract. This paper is about breakdown that occurs within the contextual frame of elderly aging in place by support of innovative welfare technology. The paper presents use of Activity Theory as a constructive framework to explore laypeople experiences with occurrences of breakdown including the subsequent coping mechanisms for recovery from such. Findings in the study display that articulation work plays an essential role to manage temporary workarounds or to accomplish recovery from breakdowns. Additionally is it sought for a minimum system requirement for robust infrastructure and high availability of services in order to prevent occurrences of medium to complete breakdowns as they in worst cases may harm the life and health of elderly aging in place.

Keywords: breakdown, laypeople, aging in place, welfare technology, infrastructure, Activity Theory, coping mechanisms, articulation work

1 Introduction

This paper is about socio-technical breakdowns that occur in the context of elderly *aging in place*[1] supported by innovative welfare technology. Breakdown is an interesting phenomenon because we live in a technology driven society, humans are daily dependent on their machines to work. When sitting behind the wheel of your car driving on the highway in maximum speed, you trust your engine to work. The same trust has elderly persons with KOLS on their oxygen apparatus for support to breathe. If the power supply is cut off, then life and health may be at risk. Similar can errors with the safety alarm system result in consequences for person who alerts if the response system prioritizes wrongly, or the alarm is triggered but fails to alert the response system, or if the alarm is not working because of flat battery. When errors like that occur they may not always have bad outcomes, however from time to time they do cause severe emergency situations. When errors caused by socio-technical failures happen, how do we talk about it and how do we deal with such errors? That is the basis for writing this paper.

The paper adds to the existing IS literature in several ways: First, we show that socio-technical breakdowns of innovative welfare services actually occur. Secondly, we explore the subsequent coping mechanisms for working around and recovering from occurrences of breakdown. Here we base our discussion on the notion of articulation work. Third, we analyze

1

how effects of breakdowns may constrain elderly people from aging in place. Finally, we show how use of Activity Theory can help conceptualize breakdowns involving laypeople, not only super users as trained professions (Heidegger 1962).

Bardram (1998, p. 89) states that *"understanding the dynamics of cooperative work is extremely important as a way to understand how to design computer systems supporting cooperative work"*. Understanding the socio-technical dynamics of introducing innovative welfare services into the contextual frame of elderly aging in place is important since such an innovation will change current work practice from existing services conducted by primarily human resources to new work practice where welfare services are being re-allocated and partly delegated to elderly and technology themselves. New practice of doing welfare services involve great responsibility and trust in both humans and technology to succeed in supporting elderly 24/7. Such an innovation will change current work practice from existing services conducted by primarily human resources to new work practice where welfare services are being re-allocated and partly delegated to elderly and technology themselves. Although many elderly are highly motivated to avoid institutionalization and live in their private homes as long as possible, they may find it challenging to handle innovative welfare technology as the technology requires users to manage navigation, interaction, configuration and maintenance of various devices. Both the elderly and the staff working in the welfare service organization are most likely untrained users of welfare technology, and therefore need to learn new practice of cooperation before becoming skilled technology users. Hence, welfare services that are delegated to technology has a higher potential for failing to handle the distributed work of responsibility in the hands of laypeople i.e. neither people nor technology may not always act or respond as planned. Therefore, a breakdown in this relation is more than merely a technical failure: breakdowns also occur because of social constructed disturbances within the relationships mediated by use of new technology.

The health authorities' have ambitious objectives when introducing welfare technology into the homes of elderly as they aim to increase their independency, safety, support and also to encourage elderly to cope with own health issues, improve communication between healthcare services, residents and their families, and by this achieve an improved cost-effective elderly care by already scarce health resources (NOU 2011:11).

The paper addresses three research questions:

1. What types of breakdown occur in the field of welfare services?
2. What are the coping mechanisms for recovery of these occurrences?
3. How do breakdowns in welfare services affect the elderly aging in place?

The paper starts with looking at the concept of breakdown, and focuses on Activity Theory as a theoretical framework to explore situations of breakdown comprising new practitioners of technology. The paper builds on fieldwork done at a location including smart homes for elderly where the elderly test introduced welfare technology. The fieldwork is a part of a larger research project about "Automation and autonomy when moving health care to the home", and the welfare technology is implemented as a part of a 2-year pilot study organized by "eSenior". The last section analyzes and discusses the concept of breakdown, occurrences and corresponding coping mechanisms for breakdown recovery.

1.1 Concept of breakdown

There are several types of breakdowns: mental breakdown, organismic breakdown, social breakdown, communication breakdowns, conceptual forms of breakdowns or equipmental breakdowns with others (Koschmann, Kuutti and Hickman 1998). This paper focuses on socio-technical breakdowns that occur in human relationships that are mediated by use of technology. Human relationships are seen as interactions between people and technology within the society's infrastructure of elderly aging in place.

The concept of breakdown has most often been accounted to the work of the German philosopher, Martin Heidegger, especially from his book *Being and Time* (Heidegger 1962). However, Heidegger himself did not use the term breakdown, even though he by many authors has been acknowledged as the originator by his recognition of "*the role of breakdown or failure as a means of revealing the nature of the world around us*" (Koschmann *et al.* 1998, p. 25). According to Koschmann *et al.* (1998), Heidegger describes the phenomenon of "*being in the world*" as *Dasein*, which is the German word for existence or being. Heidegger (1962) recognizes breakdown as a graded phenomenon, in opposite to a black-and-white view of breakdown; non-existing versus complete breakdown of habitual activities. Hence, Heidegger (1962) describes four statuses of entity from "*ready to hand*", "*un-ready to hand*", "*present at hand*" to "*purely present at hand*" (1962, p. 69/98). By this he grades tool-mediated activity of skilled users' according to the tool's appropriateness.

To illustrate his viewpoints in this matter, Heidegger uses a well-known metaphor of the trained carpenter and how his tool, the hammer, including its properties influences the carpenter's awareness or consciousness during the tool-mediated activity. Koschmann *et al.* interpret Heidegger's descriptions as follows: "*…In ordinary use, resources (tools, implements, appliances) with which we conduct our day – to-day activities do not usually require (or attract) our conscious awareness*" (1998, p 26). As the carpenter has his hammer "*ready to hand*" (Heidegger 1962, p. 69/98) and as long as the hammer is well-functioning, the carpenter is enabled to hammer without no conscious thoughts or awareness about the activity. In this status of the entity, the carpenter experiences to be within a flow of habitual practice as the activity unfold. Heidegger argues that the carpenter can be so caught up in an activity that the tool becomes completely integrated to his habitual activity (Heidegger, 1962). Thus, the carpenter experiences the tool more as an extension of himself rather than as an object from the material world.

Koshmann *et al.* further analyze Heidegger's work on breakdowns with respect to his three remaining statuses of the entity comprising situations where "*... ongoing, non-reflective practice is interrupted, these equipmental aspects of the world become "lit up"* (1962, p. 72/102) *or brought "into view"* (1962, p. 74/104) (1998, p. 26). Heidegger refers to "*un-ready at hand*" as a situation where the carpenter needs his hammer but the hammer is missing. In this situation, Heidegger argues that if the carpenter finds another hammer appropriate for the intentional activity, then the carpenter may go ahead with the activity without any further considerations. In this use scenario, the nature of the activity was initially disrupted, but may be maintained again by transformation into flow of habitual practice if the substitute hammer is appropriate for the specific activity (Heidegger 1962). However, if the substitute hammer is inappropriate for the activity, then the carpenter starts to reflect about how to approach the activity with the tool he has "*present at hand*". In this situation, the carpenter is more aware or conscious while using the equipment. I.e. if the only hammer present has a cracked handle that is taped, then the carpenter would reflect upon how much

power he could use while hammering to avoid the handle to crack even more. In addition, he may have to hold the hammer in an unusual manner that disturbs the hammering. Lastly, Heidegger describes the status of entity as "*purely present at hand*", which could be interpreted as a complete breakdown where the carpenter holds a hammer in his hand, but the hammer is in such miserable state that it needs to be repaired before it is possible to use again.

Beynon-Davies and Holmes (2002) claim that Flores and Winograd (1986) were some of the first to adapt and introduce Heidegger's concept of breakdown into the field of Computer System Design. Flores and Winograd (1986) acknowledge breakdowns in a similar manner to Heidegger as they describe it as being "*the interrupted moment of our habitual, standard, comfortable, being in the world*" (p. 77). Also the participatory design researchers in Aarhus, especially the work by Bødker (1997) have recognized the concept of breakdown in relation to design and artifacts-in-use studies. Bødker (1997) refers to breakdowns in user processes as"[*W*]*ork is interrupted by something, perhaps the tool behaves differently than was anticipated, thus causing the trigger of inappropriate operations or not triggering any at all*" (p. 149). Heidegger's work associated to the concept of breakdown is valued as essential when looking for trouble that occurs in the socio-technical context of elderly aging in place. As Heidegger argues that it is "*meaningless to talk about the existence of objects and their properties in the absence of a concernful activity, with its potential for breaking down*" However, Heidegger has restricted his view of breakdowns to merely being interruptions of habitual activities of *expert* users such as the trained Carpenter, and he has paid less attention to unskilled users or laypeople taking part in socio-technical activities to learn new practice of work before reaching a level of being an expert user. In this matter, it is necessary to look elsewhere to understand occurrences of breakdowns including unskilled users engaged in social relationships that are mediated by welfare technology.

1.2 Activity theory

Koschmann *et al.* (1998) builds on Leont'ev's Activity Theory (1974, 1978) and his understanding of activity as being "*units of life, which are organized into three hierarchical layers*" (Kaptelinin and Nardi 2012, p. 29) as comparable to Heidegger (1962) understanding of the existence or being-in-the-world. Leont'ev's hierarchical structure of activity comprises from the top; the motivated human activity, followed by the mid-layer of goal-oriented actions and the bottom level of conditional operations (see figure 1). Koshermann *et al.* (1998) especially emphasize the corresponding mechanism related to the hierarchical levels of an activity, and the traversing of levels as being associated to the concept of breakdown. However, in contrast to Heidegger, Leont'ev acknowledges that skilled users need to acquire their knowledge before achieving the status of being an expert user (Leont'ev 1978). Leont'ev argues that initially all tool mediated human activity is done by unskilled practitioners, who need to learn new practice of actions before being able to engage in a human activity as skilled users (Leont'ev 1978).

In the phase of learning, practitioners plan new activities and their actions are goal-oriented conscious actions. Only when these conscious actions are repeated sufficiently they become habitual sub-actions and by this traverse the layers and turn into routinized or habitual operations. Leont'ev further argues that routinized operations can be disturbed and change according to the original plans, which forces the operations to traverse back to the action level, and again become conscious actions of a new practice that needs to be learned

(Leont'ev 1978). The shifting mechanism between conscious actions and unconscious routinized operations therefore make the human activity dynamic as the activity always develops into new practices through learning. We acknowledge Leont'ev understanding of human activity as an appropriate lens for studying human activity of unskilled welfare technology system users that need to learn new practice of doing innovative welfare services before advancing into skilled users.
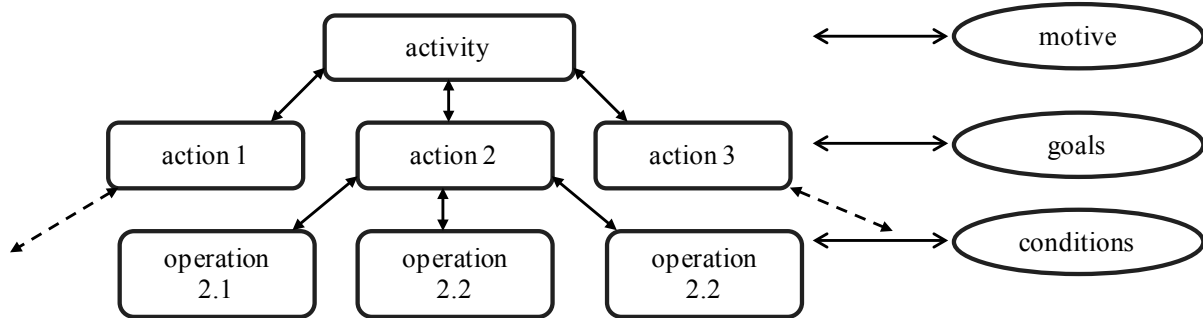

Figure 1: Illustration of Leont'ev's hierarchical structure of activity (Kaptelinin 2013 p)

Activity Theory originated within the Soviet psychology in the 1920s, its roots coming from the cultural-historical school of Vygotsky (Leont'ev 1974). The theoretical framework was further developed by Leont'ev together with his students (Leont'ev 1978). Leont'ev emphasizes the human activity as *collective* in contrast to Vygotsky, who focuses on the *individual human activity* (Cole 1985, p. 159). The framework was later applied and extended by Scandinavian researchers in mid-eighties. Since its origin the theory has continuously developed and expanded, resulting in several generations of Activity Theory (Leont'ev 1978, Kutti 1991, Nardi 1997, Bardram 1998, Engeström 2000, Kaptelinin and Nardi 2012). Hence, to capture the fundamental understanding of the collective activity from Leont'ev's work more explicitly, we have chosen to apply Engeström's activity system model for locating the breakdown occurrences within the system's mediating relationships (Engeström 2001).

Activity Theory is built upon the view that during history all human activity has been mediated by cultural tools (Leont'ev 1978). Consequently, Activity Theory emphasizes the activity as the unit of analysis (Kaptelinin 2013). This is based on the view that the world is socially constructed and where human interacts with the world by use of cultural tool(s). Each human activity has an object and it is the activity's object that differentiates one activity from another (Kutti 1991). The object varies in form and can be both from the material or ideal world (Kutti 1991). The meaning behind a motivated activity is to change the activity's object to accomplish an outcome (Kaptelinin 2013). The relationship between the subject and object is mediated by tools and signs i.e. technology, which are illustrated as a mediation triangle, see the upper triangle of figure 2. This central relationship within an activity of subject-object is placed within its basic context of the phenomenon under study, namely the community (Engeström 2001). The relationship of subject-community is mediated by rules (i.e. laws, plans and norms). The relationship between the object and community is mediated by division of labor (roles, responsibility and power that colors the negotiations of distribution of tasks).

A human activity is not static according to current plans of how an activity should evolve, but rather dynamic as plans change as the activity unfolds over time (Kaptelinin and Nardi 2012).

Instruments: Critical pathways

Object: Patients moving between primary care and hospital

Subject: Hospital physician

Outcome: Gaps, overlaps and discoordinations of care

Division of labour: Solo performance

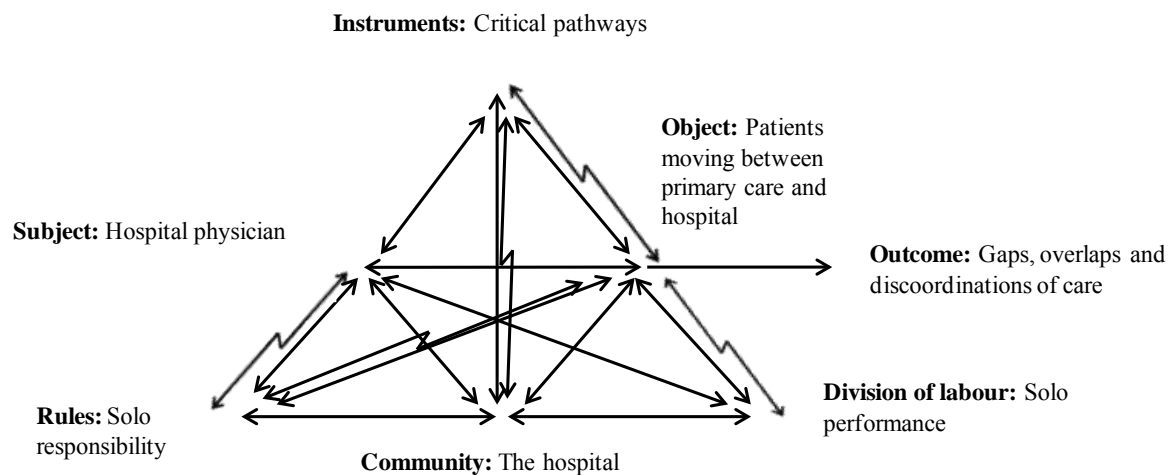Rules: Solo responsibility

Community: The hospital

Figure 2: A human activity system showing contradictions in the system of a hospital (Engeström 2000 p. 965)

For a thorough description of Activity Theory see Leont'ev (1978), Kutti (1991), Nardi (1997), Bardram (1998), Engeström (2000), Kaptelinin and Nardi (2012) with others.

1.3 Articulation work

 "*Work that gets things back 'on track' in the face of the unexpected, and modifies action to accommodate unanticipated contingencies*" (Star and Strauss 1999, p.10) is called articulation work. In situations of breakdown where various coping mechanisms are necessary for recovery, it is important to explore the cooperative dynamics between the individual and the community within the unfolding activity. Schmidt and Bannon (1992) argue that "*every real world system thus requires articulation to deal with unanticipated contingencies that arise. Articulation resolves these inconsistencies by packaging a compromise that "get the job done", that is closes the system locally and temporarily so that work can go on.*" (p. 20).

1.4 Data material

The data material for this study is based on notes from participant and passive observations from formal and informal meetings with residents, in-house staff and system providers of the existing welfare technology system. From the initial start of the fieldwork, we specifically focused on occurrences of trouble in the smart home; and observed several problems during the fieldwork even when not looking for them.

The main focus during the data collection has been to look for trouble situations including occurrences of socio-technical failures. Each apartment is equipped with an info-assistant and a safety alarm, in addition to various smart house technologies such as sensors for water lock

(flooding) and night lightning. The info-assistant is a touch based 12" tablet with Windows operative system (OS) that serves as a user portal of all in-house services with the exception of the safety alarm system, see figure 3 for illustration.

Figure 3: Illustration of user who interacts with the tablet referred to as the Info – assistant or technology. The user has the safe alarm attached as a bracelet around the wrist. Photo: Morten Brakestad.

A number of breakdowns of various welfare services at the field location have been identified:

1. Technology displays blue screen of death (BSOD).
2. The safety alarm button is pushed but the alert signal fails to go off.
3. The safety alarm reports error locations of the person who pushes the alarm button.
4. Technology is interrupted after software update.
5. The technology fails working cause of flat battery.
6. Takeaway orders are both handled by technology and manually list.
7. Safety alarm is not working as its battery is flat.
8. Apartments for couples are only equipped with one individual welfare technology "package".
9. User fails to interact within a touch based user interface.
10. Users misuse the safety alarm for other matter than critical situations i.e. social needs.
11. Welfare services are not working cause of unstable or failures in the network infrastructure.
12. The bath room lighting is turned off when elderly use the shower curtains while showering because of smart house sensors for lightning.

The list displays that breakdowns vary in shape and severity. They include socio-technical breakdowns that have occurred in user situations including smart house technology, the info – assistant (the tablet), the in-house safety alarm system and the network infrastructure.

2 Analysis

The analysis contains two selected occurrences of breakdown due to this paper's space limitation, including breakdown 1 and 3, see Woll (2013) for complete overview of analysis

in the Appendix. The analysis examines the activity system within its minimal contextual frame as the breakdown unfolds.

In breakdown 1, the elderly experiences the tablet displaying blue screen of death or so-called BSOD. The outcome is non-access to the portal including all welfare services with exception of the safety alarm. Hence, all the mediating relationships within the activity system are influenced by disturbances. This breakdown is therefore more or less a complete breakdown as it could harm elderly in situation where important reminders or health monitoring are needed. A mediating artifact displaying blue screen or so-called BSOD has an outcome of severe breakdown as the consequence of non-access to the portal of all in-house welfare services (except the safety alarm) could harm the elderly in situation where important reminders or health monitoring are needed. Additionally, in this case of mediating tool / technology breakdown all the activity system's mediating relationships are influenced by disturbances. The subject is not able to transform the object into an outcome as long as the technology which is mediating the relationship of subject –object is out of order. Hence, the subject is not able to perform any action before the tool is repaired. The law mediating relationship between the subject and community has to change or be expanded for this special occurrence of complete breakdown as the laws are not per time covering such incidence of disturbance.

Breakdown 1: Technology displays blue screen of death (BSOD)

Instruments: Tablets, network infrastructure

Subject: Elderly aging in place

Object: Welfare services

Rules: Individual instructions and plans

Community: In-house residents, residents' family, in-house staff and system providers.

Outcome: Disturbance within all mediating relationships' of the activity. The elderly is not able to recover by themselves, and has to call for assistance. The outcome could concern the health of elderly depending on the need for assistance.

Division of labour: Elderly aging in place report breakdown. The in-house staff calls after the system providers for support. The system providers have to come to explore the reason behind BSOD, and then go to each apartment within the building to fix the breakdown. While the system providers are working to repair the failure, in-house staff has to workaround technology by human resources.
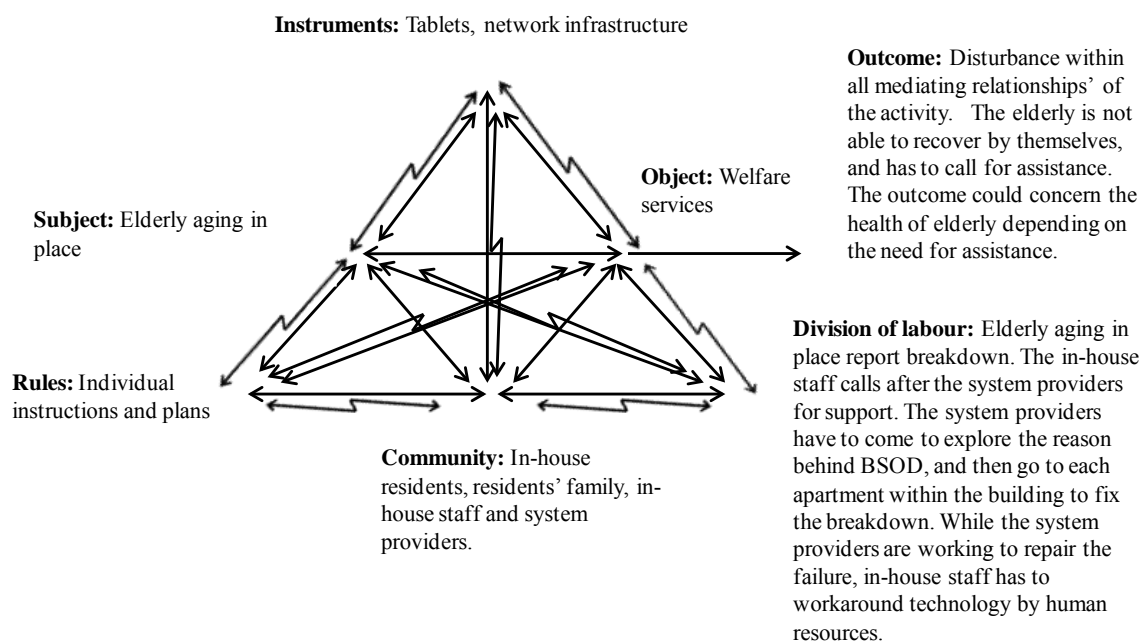
Figure 4: Illustration of breakdown that occurs in the activity system model including elderly users of welfare services.

Therefore is it necessary to implement new plans of actions and operations, especially for individual residents that are depending on critical welfare services accessible only trough the portal. Additionally, as the object is not transformed by the subject, the actors from the

community have to re-distribute division of labor as a coping mechanism to hopefully avoid the most critical outcome of the technology breakdown. In doing so, actors from the community call the system providers for support, in parallel actors will try to comfort the residents while waiting for recovery. However, it will take some time before the community is alerted about the situation of breakdown, so there should be an automatic system that warns the system providers about the BSOD incident. Furthermore could the displayed disturbances within this activity system be avoided if some sort of technology redundancy of welfare services is implemented as backup. A critical matter in this situation of breakdown is that the tablet as well offers users the functionality of mobile phone service. Hence, for some residents the tablet could be the only access to phone functionality, so the only alternative for alerting about the breakdown is by use of the safety alarm, which would be a misuse of the safety alarm system. However, regular mobile phones out of coverage or battery have the options for emergency calls, and this should be the case for this tablet as well.

Breakdown 3 : The safety alarm reports error location of the person who pushes the alarm button

Instruments: Safety alarm system

Object: Alert need of assistance

Subject: Elderly safety alarm users

Outcome: The person in charge of responding to safety alarm alerts goes to the given position. However, none at the given position has alerted for assistance. The person in charge then has to search the floor, and then search above/ below floors until she finds the person who has called for assistance. If the person who alerts is in a severe emergency situation, the extra time spent on searching floors may harm the well-being of the alerter.

Rules: Work instructions and plans developed as a work routine . In addition to individual instructions and plans if the elderly who has alerted need health care

Community: In-house residents, residents' family, in-house staff, system providers and health care staff in emergency situations.

Division of labour: The respondent of the safety alarm needs to ask other residents who are located at the given safety alarm position if they need help or if they have seen any persons who has called for assistance Other residents might engage in the search. In situations of emergency, the respondent has to call the doctor or family.
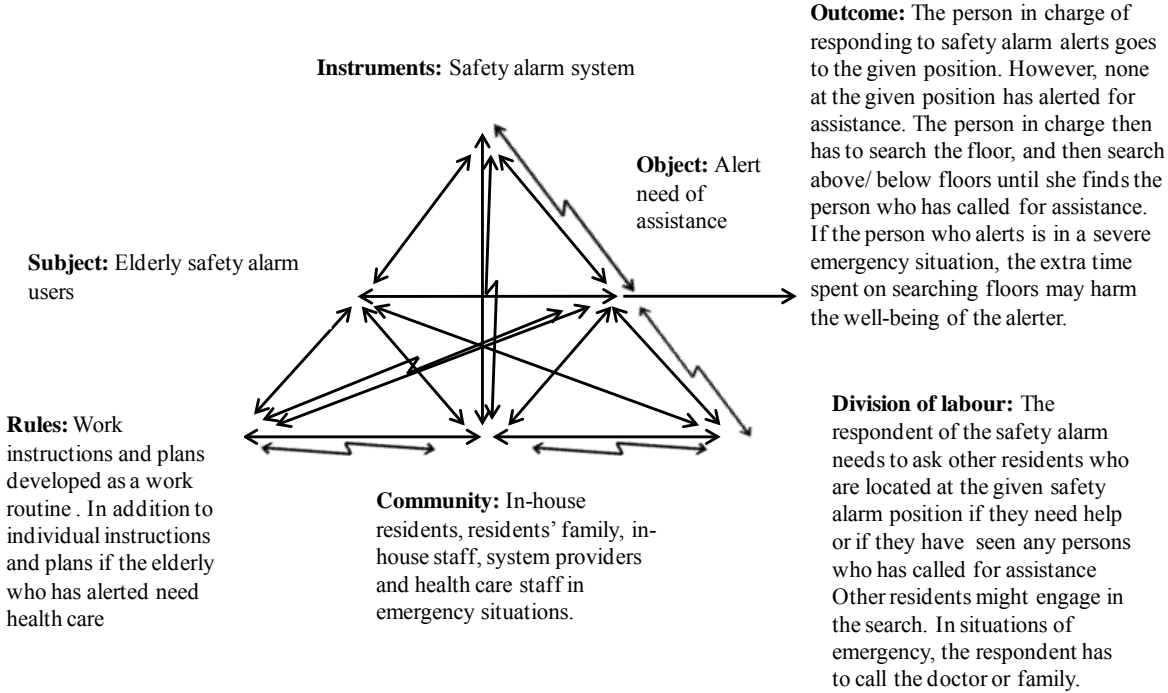
Figure 5: Illustration of breakdown that occurs in the activity system model including elderly safety alarm users.

The elderly person triggers the safety alarm and the alarm response system notifies to the alarm receiver about the person's ID and his / her local position within the building. However, the position system within in building is not working as planned because of poor coverage, and fails to report the exact position / localization of the person.

The activity system displays a subject who triggers the safety alarm button, but the safety alarm response system fails to report the subject's exact location within the building. Hence, the subject is delayed in time to transform the object into an optimal outcome as the relationship between the subject and object is disturbed by the alarm response error. However, the staff responsible for the response system knows who has alerted as they have the person's apartment number. The object - community relationship is disturbed by a re-distribution of tasks as a coping mechanism for recovery to find the elderly faster collectively, than by a solo search performance. Since if the person is hard to find in the building, then others from the community are called to help locating the person who has called for help. The staff who has worked in the building over time know their safety alarm users, and they therefore have skills or work instructions concerning persons who might have severe emergency issues versus other who just call for social issues. But they never know when a safety alarm call can be real severe emergency situation. The five disturbances displayed in this activity system could be avoided if the safety alarm system had better coverage and scale of its position system.

This system breakdown is graded as a medium to severe breakdown as it could harm the life and health of person in emergency. The effect of the disturbances is increased time before the response system is able to locate the person who has alerted. Hence, if the person who alerts is in the apartment, the staff is able to locate the person without further consequences. However, if the person has triggered the alarm outside the apartment, then the staff needs to search the building until they find the person. In cases of critical health issues, such as heart attack, this time lost could harm the life and health of persons who call for assistance.

3 Discussion

In order to address trouble that occurs when elderly people are supported by welfare services, the study has emphasized problematic situations of welfare technology usage. In doing so, the study rejects all the positive outcomes that have been experienced in the field concerning introduction of innovating welfare services, i.e. one resident experienced that he needed less medication by exercising regularly at the in-house circuit training. Additionally is situation of breakdown by itself not purely negative, as breakdown and the subsequent coping mechanism for recovery can contribute to learning, and to develop more robust socio-technical systems.

3.1 Articulation work

Throughout the analysis we found that in situations of breakdown including mediating artifacts, the artifact becomes the object as actors from the community step forward and re-distributes tasks by planning actions and operations as a coping mechanism while reporting, repairing or waiting for recovery. We see that a major shift occur in the mediating relationships of the object – community and the subject- community where actor(s) from the community take responsibility in being an active subject during the recovery process, and the mediating artifact becomes the object, that are similar to findings from Bødker (1991). The recovery process requires articulation work as an integrated part of the cooperative activity. Schmidt and Bannon (1992, p. 12) define articulation work as "*a set of activities required to manage the distributed nature of cooperative work*". They further state that" *in order to*

articulate the distributed activities of cooperative work arrangement, access to appropriate means of communication is needed." (1992, p.13). This requires a need for the welfare service organization to develop a set of rules or work instructions for situations of breakdown to handle them more efficient.

Fitzpatrick, Tolone and Kaplan (2005) claim that Activity Theory has a weakness compared to CSCW because of the theory's lack of recognition to articulation work. Fitzpatrick *et al.* recognize especially that *"[P]rocesses by which a community of actors articulate actions and operations in context, and develop (evolve) them in the face of contingencies are not well defined*" (Fitzpatrick *et al.* 2005, p. 6). They argue that this may be due to the historical perspective of Activity Theory, where Vogotsky (Leont'ev 1974) focused on the individual human activity. However, it has been several decades since Activity Theory was expanded by Leont'ev's collective activity (Leont'ev 1978) and Engeström's community (Engeström 2001). We argue that Engeström's activity system model is open for exploration of the dynamics of the mediating relationships of the subject – community, as well as the object – community. Engeström acknowledged actors from the community as being subjects in parallel activity system, sharing other versions of the system's object (Kutti 1991). However, as subjects from the community take the position as an active subject to repair or compensate a failing mediating artifact, the mediating artifact becomes an object of the system; the subject might have conflicting interest in transforming the object into an outcome i.e. avoid breakdown in harming elderly or system providers who need to show they have delivered trustable technology. Nevertheless, are subjects from the initial activity system's community an important resource in the re-organization of work practice as they articulate what have to be done during the recovery process. Findings in this study show that actors from community who perform articulation work during breakdown situations typically are the in-house staff on duty i.e. the staff in charge for safety alarm response system. Therefore to strengthen the role of articulation work in situation where it is critically needed, the law mediated relationship between the subject and the community would benefits from expanding the laws to include plans of actions and operations in situations of breakdown.

3.2   Pros and cons of applied theory

By applying Activity Theory to explore the activity systems as they unfold, it was possible to explicitly analyze the socio - technical dynamics of breakdown in-situ. This was not obvious during the initial fieldwork, which was purely focused on technical breakdowns. Additionally was it found useful to grasp breakdown in an activity system perspective as elderly supported by welfare technology is hardly an isolated user situation, as it requires a response system and robust infrastructure with high availability of services. Thus, elderly aging in place are depending on their welfare service's response system including home care nurses, in-house staff, system providers, online shops, regular GP, hospital, family with more. Engeström's activity system model is especially valuable to explore what happens in the system's dynamics when socio-technical breakdown occurs to capture the driving force of the subsequent activity systems i.e. study the adjustment, work around or coping mechanism to avoid the worst possible outcome of breakdown or to accomplish some sort of transformation of the object to a more or less satisfactory outcome.

Findings in this study display that outcomes of breakdown differ in degree as some breakdown may harm the life and health of elderly while others are just troublesome and time consuming. However, Koschmann *et al.* (1998) refer to Activity Theory in relation to breakdown as being a dichotomous phenomenon. We recognize a need to introduce a graded system that reflects the possible outcome of breakdowns. The breakdowns are therefore categorized as complete-, severe-, medium to minor in correspondence to their potential of harming the life and health of elderly. Breakdown of welfare services that may harm the life and health of elderly are unacceptable. In order to keeping elderly safe and secure, breakdown graded from medium to complete should be avoided.

By using the activity model explicit, we were also able to identify the amount of disturbances within the system. The sketched breakdown 1 illustrates a complete breakdown where all the mediated relationships were disturbed because of the blue screen of death. While breakdown 3 had only five relationships disturbed, and was labeled as a severe to medium breakdown of the safety alarm system. The amount of disturbances within an activity system may be an indicator of the degree of breakdown. However, a complete breakdown may occur without anyone noticing before after recovery. At the same time, a medium breakdown such as the safety alarm error could be life threatening if a person has an emergency outside his/her apartment and need assistance immediately. The outcomes of breakdown are therefore hard to foresee as they are depending on a number of unfortunate circumstances in the context of the specific user situation.

In regard to articulation work, activity theory was useful to emphasize the law mediated relationship of the subject and the community. When breakdown occurs there should be plans or work instructions for individual subjects such as a person depending on oxygen apparatus in breakdown of power supply. This is strength of Activity Theory when studying the dynamic of cooperative activity systems. A limitation of the chosen framework is the restrictions of the contextual frame; as it's merely focus on Engeström's activity system model's components (Engeström 2000). However, a study needs to be bounded or narrowed in scope of problem situation as it is impossible to grasp a real world phenomenon with all its complexity. Nevertheless is activity theory argued as being the most appropriate theoretical framework for this unit of analysis, when aiming to study socio-technical breakdown concerning laypeople' usage of welfare technology.

4   Conclusion

In this paper we have showed that socio-technical breakdowns of innovative welfare services actually occur in the context of elderly aging in place. The breakdowns vary in shape and severity as their outcome differs from worst case to risk the life and health of elderly, to best case being experienced as troublesome and time consuming. We argue by this that breakdowns are not a black or white phenomenon, but rather graded in correspondence to their potential of harming the life and health of elderly.

Findings in the study display that articulation work plays an essential role as a coping mechanism to manage temporary workarounds or to accomplish recovery from breakdowns. Additionally we demonstrate how use of Activity Theory can help conceptualize breakdowns involving laypeople, and not only super users as was Heidegger's main concern. The analysis as well shows how effects of breakdowns may constrain elderly people from aging in place.

Thus, this implicate a call for a support system that could take the role of performing articulation work when scaling innovating welfare services from pilot study locations into distributed homes of elderly aging in place. Additionally is it sought for a minimum system requirement for robust infrastructure and high availability of services in order to prevent occurrences of medium to complete breakdowns as they in worst cases may harm the life and health of elderly aging in place.

Notes
Aging in place refers to the individual's "ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level", see http://www.cdc.gov/healthyplaces/terminology.htm

Acknowledgments

References
Bardram, J.E. (1998).Designing for the Dynamics of Cooperative Work Activities. Poltrock & Grudin (red): *Proceedings of the Conference on Computer-Supported Cooperative Work*, CSCW'98, ACM, 89-98.

Beynon-Davies, P. & Holmes, S (2002). Design breakdowns, scenarios and rapid application development. *Information and Software Technology* 44, 579-592.

Bodker, S., (1991) *Through The Interface: A Human Activity Approach To User Interface Design*, Lawrence Erlbaum, Hillsdale, NJ.

Bodker, S. (1997). Applying activity theory to video analysis: How to make sense of video data in human computer interaction. In: Nardi, B., (ed.) Context and consciousness: Activity theory and human-computer interaction. Cambridge, MA: MIT Press, pp. 147–174.

Cole, M. (1985). The Zone of Proximal Development: Where culture and cognition create each other. In J. Wertsch (Ed.), *Culture, communication and cognition*. Cambridge: Cambridge University Press.

Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. *Ergonomics*, 43(7): 960 –974.

Engeström, Y. (2001). Expansive Learning at Work: toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1):133-156. Rutledge.

Fitzpatrick, G.,Tolone, W. J.,& Kaplan, S. M.(2005).Work, Locales and Distributed Social Worlds, 1995.*Proceedings of the Fourth European Conference on Computer-Supported Cooperative Work*, ECSCW'95, Kluwer, 1-16.

Heidegger, M. (1962). *Being and time*. (Translated by John Macquarrie and Edward Robinson). New York: Harper & Row.

Kaptelinin, V. (2013): Activity Theory. In: Soegaard, Mads and Dam, Rikke Friis (eds.). *The Encyclopedia of Human Computer Interaction, 2nd Ed.*. Aarhus, Denmark: The Interaction

Design Foundation.Available online at http://www.interaction-design.org/encyclopedia/activity_theory.html

Kaptelinin, V. & Nardi, B. (2012.) *Activity Theory in HCI: Fundamentals and Reflections*. Synthesis Lectures on Human-Centered Informatics. Morgan & Claypool. 2012.

Kuutti, K. (1991). The concept of activity as a basic unit of analysis. In *Proc. of the Second European Conference on Computer-Supported Cooperative Work* Bannon, L., Robinson, M. and Schmidt, K. (Editors) September 25-27, Amsterdam, The Netherlands.

Koschmann, Kuutti & Hickman (1998). The concept of breakdown in Heidegger, Leont'ev, and Dewey and its implications for educations. *Mind, Culture, and Activity*, 5 (1), 25-42.

Leigh Star, S. & Strauss, A (1999) Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work. *Computer Supported Cooperative Work*, 8:9–30, 1999

Leont'ev, A. (1974). *The problem of activity in psychology*. Soviet Psychology, 13(2):4–33.

Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs, NJ: Prentice-Hall.

Nardi, B. (ed.). (1997). *Context and consciousness: Activity theory and human-computer interaction.* Cambridge, MA: MIT Press.

Nardi, B. (1997). Studying context: A comparison of activity theory, situated action models, and distributed cognition. In: Nardi, B., (ed.). *Context and consciousness: Activity theory and human-computer interaction*. Cambridge, MA: MIT Press, pp. 69–102.

NOU 2011:11 Innovasjon i omsorg Helse- og omsorgsdepartementet.

Schmidt, K. & Bannon, L. (1992). Taking CSCW seriously. *Computer Supported Cooperative Work (CSCW)* 1 (1), 7-40.

Winograd, T. & Flores, F. (1986). *Understanding computers and cognition: A new foundation for design*. Norwood, NJ: Ablex Publishing Corporation.

Woll, A. (2013). Aging in place: Dealing with breakdown of welfare technology. Working paper 32 for the 36th IRIS seminar http://www.mn.uio.no/ifi/english/research/news-and-events/events/conferences-and-seminars/iris2013/groups/iris36_submission_32.pdf