Ph.D. Dissertation

How to Mitigate Task Switching between Work and Non-work-related Smartphone Use

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How to Mitigate Task Switching between Work and Non-work-related Smartphone Use

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Abstract

Today, smartphones are used as indispensable tools in almost all areas of our lives. In addition to personal activities such as watching videos and music or playing games, smartphones are widely used in business areas such as sending e-mails and writing documents. Smartphones have enabled many people to engage in leisure activities or work anywhere, anytime. However, as different areas are frequently overlapped within a single tool, users experience excessive task switching and distraction. Accordingly, the problem of cyberslacking, which interferes with work by watching games or videos while at work, and the problem of infringing on daily life, in which work orders are received after work, have recently emerged socially. Existing strategies to respond to these problems have mainly consisted of isolating and blocking uses that are not appropriate for each situation. However, in the current situation where the same device or application (app) is used for both work and personal purposes, a simple blocking strategy has its limits. In particular, in the case of apps that are used for work and personal use at the same time, such as Mobile Instant Messenger (MIM), blocking an app to prevent personal use also blocks work use, so blocking is a difficult choice in reality. Therefore, the necessity of a new strategy premised on this context is required. Following this background, this study aims to propose a new strategy to alleviate the problem of frequent switching and distraction between work and personal use in smartphones.

As the first step to design a new strategy, a study was conducted to gain a concrete and empirical understanding of the phenomenon. To this end, I collected app usage logs of users in real situations and observed how much of each app was used for work and personal purposes. In addition, specific usage patterns were observed by exploring the frequency and type of transition between work and personal use. As a result of collecting and analyzing 45,398 log events from 18 participants, work and personal use were mixed in all kinds of apps, and frequent switching between work and personal use was also observed in usage patterns. As a result, this study revealed that work and personal use in smartphones is closely interwoven with chemical fusion rather than just the level of physical bonding, especially within MIM.

In the second step, a study on the switching pattern between work and personal use within MIM was conducted by deepening the research results of the first step. To this end, this study was divided into two stages to collect conversation logs of real users recorded for 1 month and 3 months, and to analyze the types of conversion between work conversations and personal conversations. For a more detailed understanding, the correlation between conversation characteristics (rate of outgoing messages, chat participation, chat exchange frequency, etc.) and switching behavior was also investigated. Additionally, I collected users' response strategies to solve this switching problem through interviews. As a result of collecting and analyzing 103,344 and 198,505 conversation logs from 10 participants in two stages, the most common pattern was that the user switched between work and personal conversations 3 or more times when using the MIM app once. In addition, it was found that whether each conversation started with a work or personal conversation had a great influence on the overall conversation characteristics. And as a result of qualitative observation, users were uncomfortable with the frequent switching between work and personal conversations in MIM, and they were using detour strategies, such as delaying messages and checking them all at once. However, this self-management was experiencing failure. Accordingly, it was revealed that the problem of distraction between work and personal conversations within MIM needs to be resolved, and a transition management strategy is needed as an additional tool for this.

Based on the research results of the previous first and second steps, as the last step, a management strategy to reduce the switching of work and personal conversations within MIM was proposed and its effects were explored. Since there is a limit to a simple blocking strategy in a situation where personal and work conversations are frequently switched and overlapped at the level of chemical fusion, I proposed a strategy to set priorities as a way to reduce the switching between personal and work conversations. Specifically, the method of setting the temporal priority so that non-priority chats can be checked only after checking the priority conversation first and the method of setting the spatial priority so that the priority conversation is always fixed and visible first were suggested. Using this strategy, participants were asked to experience the existing message method and the new message management method in a situation where they were doing a simple task, and their reaction and work performance were observed. The Wizard of Oz experiment was conducted to allow participants to experience each message delivery and management method while doing simple tasks, and to observe the response and work performance accordingly. In addition, observational experiments were additionally performed even in real-world work situations to compensate for the limitations of the Wizard of Oz experiment. As a result, both prioritization methods showed the effect of reducing the switching between personal and work conversations, and the degree of work performance was higher than that of general delivery methods. It was found that the temporal priority method has the effect of mitigating the transition between priority and non-priority conversations even in actual work situations. In addition, in the results of the qualitative evaluation, it was found that when the priority was set, the concentration of work was high, and the satisfaction of work performance was higher.

This study revealed that work use and personal use are overlapping at an inseparable level within smartphones and MIM through the analysis of usage log

data recorded in real situations, and frequent switching is occurring in between. In particular, as there are many conversions taking place within the same app, it was revealed that the existing app blocking-centered strategy was not applicable, and that a new response was needed. These results can be used as a basis for preparing technical, academic, and social alternatives to this problem in the future. In addition, this study informs that users are experiencing inconvenience in this situation, but it is difficult to manage autonomously, and proposes a priority-based message management strategy as a new alternative that can be applied to this and reveals its effectiveness. This strategy is meaningful in that it actually presents the beginning of a new response that goes beyond the existing blocking-oriented strategy and contributes to resolving the inconvenience caused by frequent switching that users are experiencing.

Keyword : Task Switching, Distraction, Mobile Instant Messenger, Work-Life Balance, User Experience(UX), Human-Computer Interaction (HCI)

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1. Introduction

1.1. Background and Motivation

Today, we are experiencing an era in which people handle numerous aspects of life using apps. Many people today own and use digital devices such as smartphones at unprecedented levels [1], employing them in the most basic parts of daily life, from managing human relationships to using them at work [2]. In today's "everything-as-a-service" situation [3], people have little chance of living outside the boundaries of technologies such as smartphones. Every area of one's life might be closely intertwined with technology [4].

In this environment, work and leisure overlap and the boundary between the two areas is collapsing. Regardless of time and place, it has become natural for some people to listen to music, talk to friends and family, write and/or send work documents, reserve meeting places, check returns on stock investment, and chat with work colleagues on a messaging app using a smartphone. As such, the use of a smartphone for work and personal purposes can occur simultaneously. As a result, the boundary between the two areas that existed clearly in the past is becoming ambiguous for some due to the ubiquitous use of smartphones [5-10]. In the traditional working environment, officer workers often worked in an office for a fixed time until they left work [9], [11]. Going to an office, until some time ago, meant complete separation from the private sphere [12]. However, as most of the public began to use smartphones in the late 2000s, people's work and leisure behaviors converged [13–16]. Smartphones have been widely used in the field of work beyond personal use because they allow users to connect with others easily through a network, increase communication efficiency, overcome time–space constraints, and increase work efficiency to contribute to productivity improvement [2], [7], [13], [17–19].

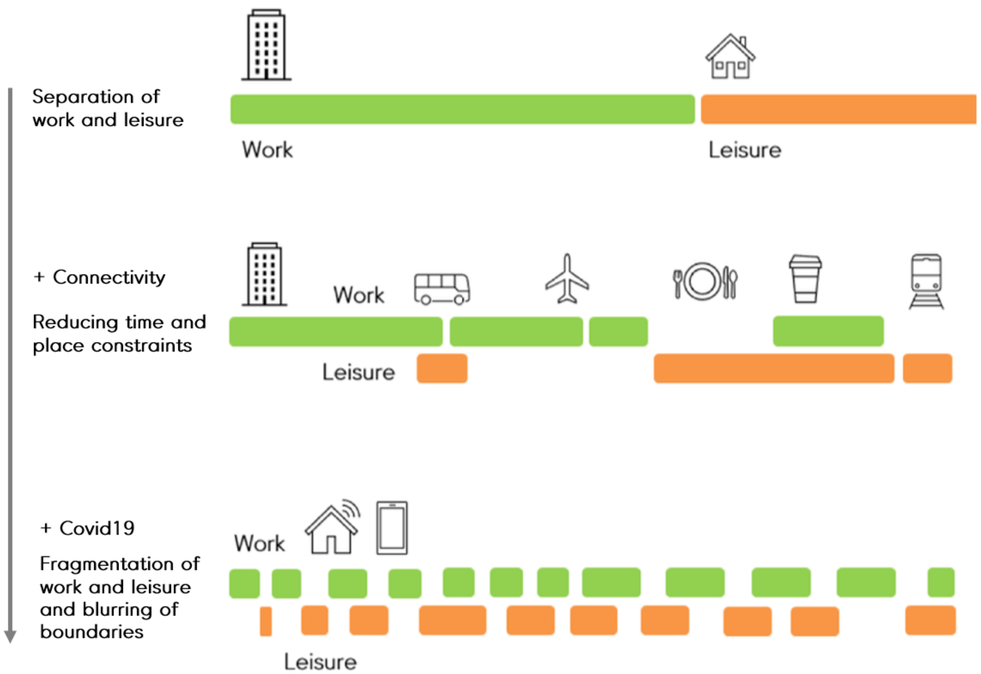


Figure 1 Changes in the boundary between work and leisure due to the spread of information devices (smartphones)

Furthermore, in recent years, the collapse of these boundaries has accelerated as social distancing, telecommuting, and online work have spread worldwide due to the COVID-19 pandemic [20], [21]. In cases of face-to-face contact being restricted by policy, many people spend their leisure time while working from home. Many business meetings have been replaced by online meetings or work messages, and daily leisure activities such as meeting and walking with friends have been largely replaced by video services or online communication. As a result, the environment for many people has changed in a way that frequently mixes the areas of work and leisure (see Figure 1).

Task Switching and Distraction

With the widespread use of smartphones in many areas of life, including work, users are exposed to excessive multitasking [2], [22], [23], and they could experience frequent switching between work and non-work tasks that occur simultaneously on their phones [24]. The use of smartphones, such as for messaging friends, playing games while working, checking work conversations or emails, and receiving work calls while ordering delivery food from home, is no longer a rare experience for many people. This type of experience can be conceptually viewed as task switching. The concept of task switching, which has been studied in the field of human–computer interaction, refers to a state in which users pursue multiple goals at the same time in a multitasking situation in which they perform two or more tasks simultaneously [25], [26]. That is, to process all tasks at the same time without one central task, a user switches between a plurality of tasks. This outcome is conceptually different from an interruption, which refers to external factors that cause a disturbance in a situation where a person performs one central task [27], [28].

During task switching, the user's concentration and effort alternate for each task

[29]. This kind of work is bound to involve cognitive interference [30], and the user consumes cognitive resources during each transition [31–33]. In particular, switching between tasks in different contexts rather than within the same context increases the switching cost and further intensifies the problem because a new task set has to be constructed that is not related to prior work [34]. This is because when a user performs a task, the task set, which is a resource set of related information, plans, procedures, and knowledge, remains unconsciously, affecting the time and cost required to configure a new set of tasks [34]. Thus, heterogeneous switching between work and non-work use can result in higher switching costs, more cognitive impairment, and poorer concentration, as well as problems with work performance [27], [34], [35].

With this background, frequent transitions consequently lead to a problem of distraction of attention to the task. Distraction refers to the distribution of concentration on an object, and digital distraction refers to a phenomenon in which one’s concentration on the main tasks currently being performed is hindered by electronic devices or digital media [11]. In addition, digital distraction involves multitasking by digital media, meaning that the behavior is perceived as a problem or obstruction to a person [36]. As described above, the new digital environment can weaken a user’s concentration and cause a large cognitive burden [1]. Digital distractions make it difficult for a user to focus on one task, and the user is continuously required to switch to an activity in another area [1]. In the end, a user becomes distracted because his or her attention is constantly dispersed between work tasks and non-work tasks on a smartphone.

Furthermore, the distraction caused by task switching has led to social problems beyond the individual level. In business situations, cyberloafing (i.e., using a smartphone for private use) interferes with the work being performed [37]. This concept was first described by Kamins in 1995 [38]. In Korea, the amount of time people spends using smartphones for private purposes during work is recognized as a social problem, for which the term "salary lupin" has been coined. Salary lupin refers to people who do not work properly and receive salaries. In addition, in the non-work area, problems of interference with daily life occur due to work contact delivered after work and stress due to increased workload [39]. Many people are always connected to their smartphones, which causes a problem whereby they cannot separate from work even after work.

Coping Strategies and Limitations

To cope with excessive task switching and distraction problems, various strategies have been studied and applied in the field of human–computer interaction [40–43]. Although research has been conducted to help users curb the amount of use or to find an appropriate point of interference, methods of blocking unnecessary tasks occupy a large proportion of the literature [40], [43], [44]. Service providers such as Apple and Google include the ability to block certain apps in their smartphone operating systems [45], [46]. A method has also been studied to allow users to set a time limit for a particular app and then block its use if that time is exceeded [47], [48].

However, the existing response strategies have several limitations. Although blocking strategies have strengths, they are not applicable in all cases [44]. First, the current situation in which work and non-work are mixed by smartphones has irreversible characteristics that prevent a return to the past. In many cases, the traditional 9-a.m.-to-6-p.m. work model has become a flexible and distributed work model [49], [50], leading to a virtual office era in which people handle tasks using information terminals such as smartphones regardless of location and time [15]. For many, today's work is not limited by time and place, but has become betwixt and between, which involves flexibility and uncertainty [51]. In addition, due to the

COVID-19 pandemic, non-face-to-face work from home has spread rapidly. In this situation, returning to the past work pattern in which work and non-work areas were clearly separated can be considered realistically difficult. Second, using a smartphone for personal purposes during work have complex values not only interferes with work, but can also contribute to increasing productivity through micro-breaks [52–54]. Therefore, it is difficult to expect that the blocking strategy would bring only positive effects. Third, the existing blocking method was applied to apps, but the mix between work and personal areas is gradually occurring in a more microscopic range. Many apps, such as email and web browsers, are used not only for personal purposes, but also for work. In particular, in the case of a mobile messaging app, file transfer is convenient, group conversations are easy, and there is no additional cost. Thus, mobile messaging apps are actively used for business conversations as well as personal conversations [55], [56]. Blocking a messaging app to prevent personal use also blocks business conversations, making it difficult to apply a blocking strategy in reality. Finally, although blocking is intuitively a powerful management strategy, users may feel uncomfortable with excessive intervention and restrictions, or they may break the rules and bypass the management app [18], [47], [57]. When the usage time limit is reached, a user can delete the management app that blocks the use of the desired app or change the management rule to allow its use [58]. As a result, in the current smartphone usage context, it is difficult to completely separate work and personal use, and it is difficult to block one side, so there is a limit to applying the existing distraction management strategy. Therefore, it is necessary to study a new strategy that can alleviate the distraction in a smartphone and the excessive task switching between the two areas under the premise that work and personal use are mixed.

1.2. Research Goal and Scope

The goal of this study is to explore empirically the problem of mixing and switching between work and non-work areas in a smartphone, reveal the type of switching, propose a priority strategy to alleviate the problem of switching and distraction, and observe its effect. In this regard, the specific problem phenomenon to be dealt with in this study can be expressed as shown in Figure 2.

This study aims to explore changes in work and non-work contexts as well as how the transition between work and non-work use of smartphones occurs based on actual users' usage log data, in addition to observing the conversion behaviors and types. Additionally, the concepts of work and non-work use covered in this study are widely used to refer to work-related use (e.g., checking work email, having work conversations, or transferring work files) and personal and/or leisure-related use (e.g., travel planning, accommodation booking, or meal reviews) on smartphones.

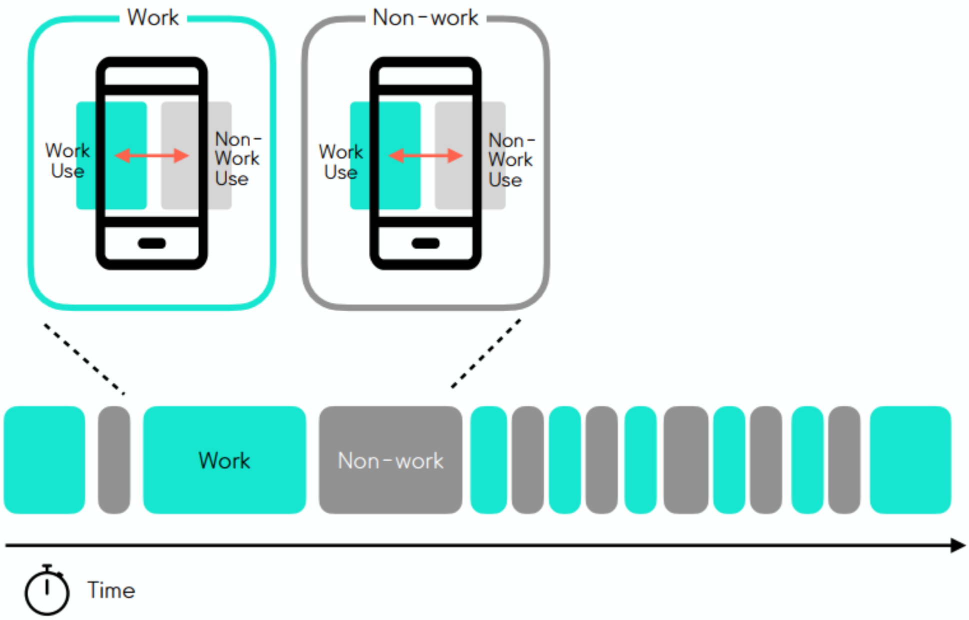


Figure 2 Phenomenological scope of the study subject

In addition, the categories of problem phenomena that are the subject of this study can be represented as shown in Figure 3 in terms of the level of multitasking. The media multitasking situation in which task switching takes place can be divided into five types according to the use and type of media as shown in Figure 3, based on the discussion of previous studies [29], [36], [59].

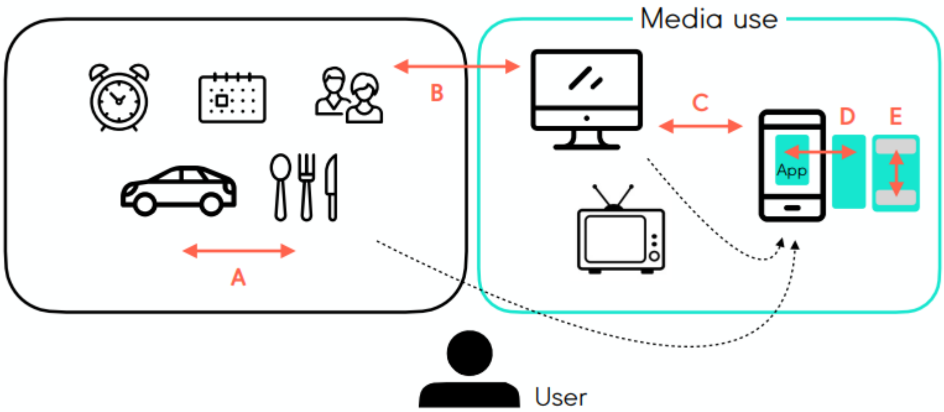


Figure 3 Scope of study subjects in terms of task switching

In Figure 3, (A) denotes a transition between non-media-related behaviors (e.g., talking while driving). (B) indicates a switching between non-media behavior and media use (e.g., eating and watching television). (C) means multitasking and switching between media. (D) shows multitasking and switching behavior within one media format, such as switching between apps within a smartphone. (E) is the most microscopic type, meaning the transition between each action within an app (e.g., switching between work and personal chat rooms in a single messaging app). This study focuses specifically on types (D) and (E). I explored the transition between work and non-work app use on smartphones (Chapter 3) and the transition between work and non-work conversations within a messaging app (Chapters 4 and 5).

1.3. Thesis Statement and Research Questions

Because smartphones are widely used in almost all areas of many people's lives, a mixture of personal and work areas appears in this personal device, and switching between different areas occurs frequently. In this situation, users might experience a problem due to switching between work and non-work use and the resulting distraction, and this problem is intensifying, especially in mobile instant messenger (MIM). To alleviate the problem, I empirically explored the switching types between work and non-work use in smartphones and MIM. Based on my analysis, I proposed a priority strategy for message management and found that it is effective in reducing task performance and switching compared to the existing general message-based delivery method.

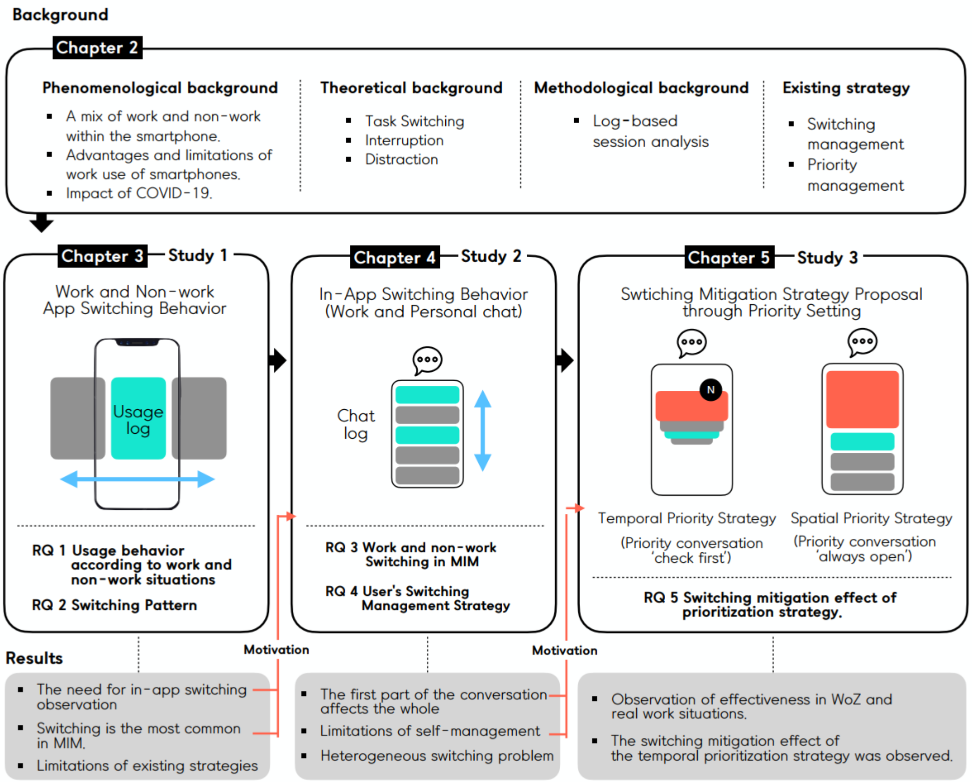


Figure 4 The structure of the study and the research question

In this regard, this study establishes the research structure and problem (Figure 4), explores the phenomenological, theoretical, and methodological backgrounds related to the research goal (Chapter 2), and conducts detailed research in three stages (Chapters 3, 4, and 5). Next, I would like to explain each detailed step-by-step outline and research question.

1.3.1 A study on switching between work- and non-work-related app use (Chapter 3)

In the first stage, as a basic study to design a switching mitigation strategy, I explored the way work and non-work use takes place in smartphones according to work and non-work situations. In addition, I explored the ways people switch their use of apps for work and non-work purposes in each situation. This study collected and analyzed usage logs recorded in the field to understand usage patterns that are more practical. Through this, I drew results showing how and the extent to which the mixture of work and leisure takes place on smartphones. In particular, it was revealed that more mixed use takes place in mobile messenger apps compared to other apps, and there is a need to explore micro-switching in apps. The research questions explored through the detailed study in Chapter 3 are as follow:

RQ1. How do users' smartphone usage behaviors differ according to work and non-work situations?

- How do people's smartphone usage time and density, as well as the apps they use, differ according to work and non-work characteristics?

RQ2. What is the extent of users' mixing of smartphone usage between work- and non-work-related usage and in what ways do they mix their use?

- In work and non-work situations, what is the extent to which the mix between work use and non-work use appear, and what is the transition pattern?

1.3.2 A study on switching between work and non-work conversations in a MIM app (Chapter 4)

In the study conducted in Chapter 3, the need to observe in-app switching more microscopically was raised. In particular, mobile messaging showed the highest switching and usage. Based on this, I further refined the research subject, explored the types of transition between work and personal conversations within mobile messengers, and studied users' response strategies and perceptions from a qualitative research perspective. Through this, I tried to understand empirically the degree to which people switch between work and non-work conversations within a mobile messenger.

Conversation logs in real work chat rooms and personal chat rooms were collected twice for 1 month and 3 months to derive the switching type, the amount of work and personal conversations, who initiated the conversation, the degree of participation in the conversation, etc. The purpose of this study was to analyze how characteristics correlate with these transitions.

As a result, it was possible to collect users' self-management strategies. In addition, through the limitations revealed here, it was revealed that a human–computer interaction-level response strategy was necessary. Moreover, I found that the nature of the overall conversation could be determined by whether the user initiated the conversation for work or personal purposes. The research questions explored through the detailed study in Chapter 4 are as follows.

RQ3. How do the switching patterns and distributions between work and non-work conversations appear in MIM?

- What is the pattern of switching between work conversations and non-work conversations within MIM?

- How does each type of switching, such as heterogeneous switching (work-non-business) and homogeneous switching (work-business, non-business-non-work), correlate with conversation characteristics (conversation participation rate, conversation frequency, initiation or not)?

RQ4. How do MIM users manage switching between work and personal conversations?

- What are the types and effects of detour strategies that users autonomously attempt to resolve due to inconvenience caused by distraction in using MIM?

1.3.3 Proposal of prioritization strategies for mitigating switching (Chapter 5)

In the last step, based on the research results of the previous two steps (Chapters 3 and 4), I tried to propose a new strategy to alleviate the switching and overlapping problems between work and non-work areas that users experience in MIM. To this end, I explored the limitations of the existing response strategy, proposed a method of prioritizing the desired message as a new strategy, and explored its effectiveness. Through the Wizard of Oz method, I explored the situation of conducting business conversations and personal conversations while performing virtual tasks, as well as field studies in real work situations. As a result, it was found that the temporal priority strategy, in which the user must first check high-priority conversations to expose the rest of the conversations, had a high effect of mitigating switching and increasing work performance, and based on this, the implications of the priority strategy were derived. The research questions explored through the detailed study in Chapter 5 are as follows.

RQ5. What is the effectiveness of chat prioritization as a user experience strategy for mitigating switching behavior?

- What characteristics does the priority-based message delivery strategy have compared to the existing message delivery method?

- What difference does the priority-based message delivery strategy have in performance compared to the existing message delivery method?

- What is the user's perception and qualitative evaluation of priority-based message delivery strategies and existing message delivery methods?

1.4. Contributions

This study is meaningful in that it empirically explored the overlapping and switching problems between the work and personal areas users experience in the use of smartphones and mobile messengers and suggests practical solutions for alleviating the problem. Specifically, the study can be described in the following three aspects.

Empirical research contributions: In this study, a more realistic switching type between work and non-work was derived by performing session classification analysis by collecting the logs that users actually used in work and non-work situations on a large scale. In addition, through qualitative research such as diary analysis and interviews, users' responses and detour strategies were collected and were analyzed together with the context of work and non-work switching behavior and distraction problems. Through this, I have drawn a result that can examine the newly emerging work and non-work mix and the distraction problem caused by excessive switching between them from multiple perspectives, which is expected to contribute to designing other studies related to this problem in the future.

Strategic implications for the user experience: Based on the data collected through quantitative and qualitative analysis, this study deeply identified problems related task switching in mobile messaging apps, pointed out the limitations of existing countermeasures, and proposed a new type of response strategy to mitigate them. Specifically, unlike the existing task insertion strategy, which mainly assigns tasks with low relevance to the work context, such as button input and text input, in the case of the strategy presented in this study, a work conversation is presented as an actual task so that it can be checked first. This strategy meaningfully reduces deviations in the context of work and prioritizes checking the contents of priority conversations before non-priority conversations. In addition, unlike the existing strategy of delaying notification by using separate rules, the method proposed in this study is more closely related to work by allowing the delay to be determined fluidly according to the time the conversation-checking task occurs. It is also meaningful that it proposes a method that does not reduce a user's autonomy by blocking or restricting the use of the app and that does not distort a user’s natural use context by adjusting the priority of message checking. Finally, the switching mitigation strategy proposed in this study is meaningful in that unlike the existing app unit management strategy, it can manage the switching behavior that appears within one app. These results are expected to provide new clues to overcome the limitations of traditional methods when trying to manage messages that are actually mixed with each other in mobile messaging apps in the future.

Theoretical contribution: This study revealed that mixing and overlapping between different conversational areas takes place during smartphone use by analyzing switching behavior in the context of work and non-work usage beyond the existing task-switching level and deriving its meaning. These results are expected to provide new domain knowledge to smartphone log analysis or task switching research flows.

1.5. Thesis Overview

This study consisted of seven chapters, as previously described in the study structure (Figure 4).

Chapter 2 summarizes existing studies related to the problem of mixing work and non-work behaviors on smartphones. Specifically, the concept of interruption and distraction was described as a concept related to task switching. In addition, the advantages and limitations of smartphone use during work and the countermeasures found in existing research to solve distraction problems that occur while using smartphones were summarized.

Chapter 3, as the first step in the overall study, typified the app-switching pattern between work and non-work use within the smartphone, and it explored the ways work and non-work use occur in work and non-work situations. These results provide an important foundation for carrying out Chapter 4 by specifying the scope of the study.

Chapter 4 is the second stage of this study. Based on the results of the first stage, it describes the results of a study conducted on MIM, which showed the highest level of inter-domain switching and mixed work and non-business domains. The results of exploring the way switching between work and personal conversations occurs within MIM and which detour strategies users apply to cope with frequent switching and the resulting distraction are explained.

Chapter 5 is the third and final stage of this study. Based on the research results of the previous two stages, I propose a priority strategy that is different from the existing distraction response strategy and describe the results of evaluating its effect.

Chapter 6 analyzed the implications of the research in more depth by discussing the implications derived from the detailed studies conducted in three stages.

Chapter 7 summarizes the study’s results and areas of contribution, in addition to describing the direction of future development.

2. Literature Review

2.1. Blurred Boundaries Between Work and Leisure

In a situation in which work-related and personal activities in smartphone use overlap, I aimed to focus on the behavior of switching between work and non-work activities on one device rather than focusing on either one individually. I aimed to examine the problem of the loss of concentration when they frequently switch between and mix purposes in their smartphone use.

To this end, in this chapter, I first write about how extensively people use smartphones in work and non-work situations and how people use them for many purposes in connection with their characteristics. Next, I examine how people use smartphones for work. Because a smartphone is a personal mobile device, it is natural to use it for personal purposes. I determine how often people use smartphones for work and how they do so, and I summarize the pros and cons of using them for work. Then, I examine how the use of smartphones for work has changed the patterns of work and non-work as well as how COVID-19 has exacerbated all the preceding situations.

2.1.1 Use of Smartphones for Work and Non-Work—The Smartphone as an All-Purpose Machine

With the development of technology, smartphones are always with us throughout our daily lives, including in work, leisure. People use smartphones in a variety of ways, including sending emails, looking at calendars, making appointments, listening to music, and surfing the web [60], and they actively use them for learning [22]. As a result, people inevitably undertake a mix of activities with various purposes on one device. Ludwig et al. [2] stated that smartphones have conquered most of our lives and are involved in nearly all activities. Hallnäs and Redström [61] noted that these mobile technologies are more than tools used for specific needs and have become part of people’s lives in a deeper sense.

A smartphone is an all-purpose machine with many features, sensors, and functions [62–64]. People can use them in work and non-work situations through various applications, such as email, web browser, music player, camera, and games as well as basic phone and text functions. Furthermore, as smartphones’ computing power has improved significantly, they can replace much of the work that a PC used to do, and Nikou [65] predicted that all tasks, work and non-work, would be possible with smartphones and tablets. In particular, technological advances have made it possible for users to remain highly connected online at all times [2], [6], [13], [14], [66], [67]. These characteristics are also relevant at work. Users can connect to work anytime and anywhere using their personal devices, such as smartphones and tablets [67], and theoretically, work has become more flexible and people can work anywhere at any time [2]. In addition, smartphones are portable. The resulting mobility enhances this connectivity. No matter where we are, even on the go, our smartphones keep us connected with people and, potentially, our work.

With high connectivity and the improvement of smartphones' computing power, expectations for the use of smartphones in work have increased, and they have been used extensively for such purposes. Many studies have shown that these characteristics of smartphones enable people to use them for work [2], [8], [13], [15], [67–73].

2.1.2 Work-Related Smartphone Use

Smartphones are personal devices, but for various reasons mentioned in the previous section, people can use them for work. Agger [13] defined the smartphone as a new company and stated that email and texting are the new labor process. Users are increasingly using their personal devices, such as smartphones, for work [2], and some employers expect such usage [18], [74] found that the more employees perceive that the company they work for supports their use of smartphones for work, the more they use their smartphones for work. In other words, employees are actually using smartphones for work as much as the organization expects. In Korea, where the smartphone penetration rate is high compared to the rest of the world, 70.3% of respondents had used smart devices for work outside of working hours. Of these smart devices, 76.5% were smartphones [71], [73] referred to smartphones as "major teleworking tools." However, using a smartphone for work is a double-edged sword [7].

1) Benefits

Using a smartphone for work has various advantages, which researchers are studying. In the field of management information systems and organizational behaviors, interest in corporate members' use of smartphones is increasing. Kim et al. [18] listed the positive effects of smartphone use: 1) productivity improvement, 2) efficient communication, and 3) improved decision making. They also saw that smartphones' information, social networking, and resource management functions enhance role performance among individuals. Towers et al. [75] found that work-extending technology allows for flexible management of work time and place, making accommodating work and family relationships easier.

Duxbury and Smart [9] examined how the development of mobile technology affected people's work-life balance. They found three advantages of using mobile technology for work: 1) increased work hours, 2) improved accessibility allowing people to work anywhere and anytime, and 3) opportunities for monitoring and control users. However, these are benefits for employers. The primary benefits from the user's point of view can be organized into the following two categories. First, mobile technology allows users to control when, where, and how they work according to their needs. This is a strong incentive for users to use their smartphones for work [9]. The second benefit from the user's point of view is that they can use such technology to make a good impression on the organization. It is useful for showing a committed image of being connected anytime and anywhere and being able to work on weekends and holidays [9].

2) Problems

Despite these various advantages, the use of smartphones for work has many disadvantages. One of the critical problems is that work-life balance can be disrupted. With smartphones, work will inevitably be mixed with personal time because of notifications even if the user does not intend for such disruptions because they are easily placed in a context in which the company can contact them even after work, breaking the boundary between work and non-work and causing smartphone distraction. Numerous researchers have identified this trend [5–10], [67], [71], [76–78]. Prolonging work hours by being able to work outside the office may be beneficial for employers, but for employees, the work-life balance may be disrupted by increased workload and intrusion into time with family [9], [79]. The use of personal devices not only in personal time but also in the work environment blurs the boundaries between work and personal life, and distinguishing or prioritizing personal and work purposes when using mobile devices can become difficult [2]. Duxbury and Smart [9] found that mobile technology has created work extensions and enabled people to work outside the office, blurring the lines between home and workspace. As a result, role conflicts occur at work and at home and achieving a work-life balance can be difficult.

Another problem is the increase in workload. Many studies have revealed that the use of smart devices increases the user's labor intensity or workload [71]. Thomas [67] found that working hours increase as work flexibility increases, and employees feel pressure to work all the time. In a study of Canadian knowledge workers, 70% of respondents said that their use of a BlackBerry increased their workload [9].

The fact that smartphones are used for work does not only have a detrimental effect on employees. The use of smartphones during work not only increases work productivity and efficiency but at the same time can cause cyberslacking and cyberloafing, problems that interfere with work as people undertake actions unrelated to work [37], [39], [80]. "Cyberslacking" refers to the use of the Internet or mobile devices for personal purposes during working hours [39], [80]. Neill et al. [39] analyzed cyberslacking. With the development of communication technology, workplace restrictions have decreased, and telecommuting has increased to increase productivity. However, Neill et al. [39] argued that cyberslacking has occurred extensively because it is not visible to supervisors and colleagues. Vitak [80] noted that cyberslacking is an important issue because it can cause a company's revenue loss. Vitak et al. [80] and McBride [37] noted that health care workers use personal communication devices (smartphones and tablets) for non-work-related purposes during work hours. The frequency of use during work was investigated, emphasizing that such use could be a potential hazard to patients. Of the respondents, 78.1% stated that they used personal communication devices for non-work-related purposes during work [37]. The work use of smart devices tends to increase workers' performance, but Lee and Kim [71] found that this positive effect is weakened as the use of smart devices for non-work-related purposes at work increases.

2.1.3 Fragmentation of Work and Leisure

One of the important phenomena stemming from the use of smartphones for work is the fragmentation of work. In the past, people worked in a fixed place at a fixed time, but IT technology has revolutionized work and life and separated work from the traditional office space [15]. By the 1980s, Nilles [81] predicted that telework would be possible with the help of technology and that in the future, work would be moved to or near the home. Messenger and Gschwind [15] stated that this telework evolved with new ICT(Information and Communication Technology) and changes in work location. They suggested that the existing telecommuting environment is a home office with personal computer, and the next generation was a mobile office that enabled work in a third space other than home with mobile phones and laptops. As smaller, cheaper, and more easily connected devices, such as smartphones and tablets, are rapidly becoming more common, the virtual office has become the third generation of telework. Messenger and Gschwind [15] argued that as a result, work is more fragmented and occurs occasionally and that it is carried out in an intermediate space and even in virtual space. As a result, users can receive contact from work anytime and anywhere through their smartphones and tablets, which they carry with them at all times, and, if necessary, they can engage in personal time between work periods.

Fragmentation of work inevitably led to fragmentation of leisure. Unlike in the past, when people enjoyed long-term leisure activities, such as eating out, reading, watching movies, and traveling during their long personal time after work and before going to bed, the unit of content appreciation or experience has gradually become more short-term. Lindström [36] and Wescott [82] pointed out that media consumption is increasingly fragmented. News is becoming increasingly mobile and fragmented as new types of news are produced [83]. Even streaming music and video content is becoming more granular and easier to access and digest [36]. This trend becomes clearer when we look at actual service cases. Short text-limited tweets and Snapchat videos as well as media clips such as YouTube Shorts, TikTok videos, and Instagram reels show how people around the world are consuming media content.

2.1.4 Using MIM Apps on Smartphones for Work

Among smartphones' numerous functions and applications, mobile instant messenger (MIM) apps are some of the most frequently used. They are also frequently used for work. Of the reasons for using smart devices for work outside of business hours, the largest proportion, 63.2%, was receiving and sending mail, and the second was work processing and instruction through MIM and SNS(Social Network Service) apps (47.9%) [71]. As the use of MIM apps has increased, so has the number of smartphone notifications [84]. Unlike email, web browser, and document applications, MIM apps enable real-time chats, so they can more easily intrude into people's daily lives. Such intrusions can be stressful because most people see MIM notifications almost immediately [48], [84–87]. The use of MIM apps for work means receiving more notifications, penetrates users' daily lives anytime and anywhere, and blurs the boundary between work and non-work. At the same time, it increases smartphone distraction.

2.1.5 Impact of COVID-19

The pandemic situation caused by COVID-19 has exacerbated and accelerated the phenomena mentioned above. COVID-19 has not only brought about major economic and social changes at the macro level but also profoundly altered individuals' lives [3], [20], [21], [88–94]. According to Deloitte [3], the pandemic has further blurred the line between physical life and the digital world because all daily activities, including work and school, have entered the home [88], [91].

Quarantines and social distancing due to COVID-19 have inevitably led to a surge in the use of digital technologies [91], and these demands have prompted businesses and educational institutions to enter a work-from-home mode to address the issue [90], [91], [94]. In fact, telecommuting is not a new concept that arose with COVID-19. Messenger and Gschwind [15] had predicted that telework would take place in the 1970s and 1980s, but most companies were not actively adopting it. However, the pandemic has accelerated the switch to telecommuting. In particular, with the increase in telecommuting and in asynchrony among people who work together, work is more often distributed than continuous.

In addition, COVID-19 has had a tragic impact not only on social and economic dimensions but also on individual lives. Due to COVID-19, tasks that people used to outsource to babysitters, school teachers, and cleaners suddenly became their own, even when they weren't ready [20], because the quarantine made leaving the house and letting others into the house difficult. With kindergartens and schools locked down, parents had to look after their children all day at home and prepare them for online classes. In addition, almost every aspect of life, such as dining, shopping, entertainment, education, and exercise, has changed and become digitized. People order meals through applications and receive deliveries. Online shopping and OTT service use has increased. Exercise has become home training. Instead of going to school, students take online classes and meet friends in virtual worlds, such as games and the metaverse. As the time at home increases and most activities become digitized, smartphone distraction will inevitably become more severe. Due to COVID-19, people have to handle numerous daily activities, including work-related ones, with a smartphone. However, studies on the collapse of the boundary between work and non-work caused by this trend are still lacking.

2.2. Task Switching and Distracted Smartphone Use

I examined the problem of blurring the boundary between work-related and personal smartphone use. As I stated in the Background section, in this situation, users experience frequent switching between work use and personal use. Doing so during work situations may cause disruption to work, and switching in personal leisure time may interfere with personal relaxation. As a result, the user may experience a situation that that keeps them from performing their main task: distraction.

Therefore, regarding this phenomenon, in this chapter, I examine the flow of studies and related concepts in the field of task switching. I also seek to understand the phenomenon better by reviewing studies in the field of interruption as a related concept. In addition, I examine the digital distraction problem resulting from such task switching along with its aspects.

2.2.1 Task Switching

"Task switching" means a person repeatedly shifts their attention and efforts between tasks [29]. It is an area of the multitasking concept [95]. People are often required to switch frequently between cognitive tasks in their daily lives [32]. This process involves conscious and unconscious switching. Wylie and Allport [34] stated that switching involves a kind of control switch that switches the cognitive processing system from one configuration of a task to another.

Jersild [96] devised the task switching paradigm. Jersild [96] asked students to perform one task repeatedly or alternately with another task and investigated how mental resources were reconfigured during this switching process. Jersild's [96] method was to compare the time required for shifts and repetitions. Researchers studied task switching in the 1990s and are conducting more research with the recent emergence of various digital devices and rapid increase in multitasking. They have mainly studied the types of task switching, the problems that arise, and methods for reducing the switch cost [32], [34], [97–104].

Concepts closely related to task switching are as follows:

- Switch Cost: When switching tasks, concentration decreases, work time becomes longer, and errors are more likely to occur. This is called switching cost. When switching two or more tasks rather than repeating one task, this cost increases, and although it can be slightly reduced through the preparation process, it cannot be eliminated (residual cost). Switching cost is usually measured as the difference in response time between repeated switching and non-switching attempts [32], [34].
- Preparation Effect: When prior knowledge about the next task is given or preparation time is given before task switching, the switching cost is reduced [32], [35].

- Recovery/Reconstruction: When returning to the original task after task switching, the user needs to reconfirm the task and reconstruct the context to return to the previous task [35], [105].
- Residual Cost: Switching costs can be reduced through preparation, but generally cannot be eliminated. Even if the switching cost is reduced by providing sufficient preparation time, it does not completely zero and reaches a kind of asymptote, which is called the residual cost [32].
- Task set: A task set is a set of resources (information, plan, procedure, knowledge, etc.) related to a given task. Task switching causes the reconfiguration of this task set and incurs costs in the process [34].

Task switching places a degree of mental and cognitive burden [106]. In general, task switching is referred to together with switch cost, and many studies have investigated ways to measure and reduce this switching cost [27], [31], [32], [35], [95]. If one stops working and moves on to another job due to external interference, one falls into a “chain of distraction” consisting of preparation, diversion, resumption, and recovery [35]. Even after interrupted work is resumed, the cognitive cost still includes interruption residues [27]. Task switching degrades concentration and makes a person prone to errors immediately after switching. This is called the “switch cost.” Monsell mentioned a residual cost that can be reduced slightly by preparation but cannot be eliminated [32].

Dzubak [95] also noted that switching from one task to another has a time cost associated with mental juggling or switching cognitive gears. He performed task switching experiments to measure the cost and time lost during the switching process [95]. According to Czerwinski's study of interfaces related to task switching, it was found that the method of capturing and remembering representations is useful in reminding the user of a suspended task and helping the user to switch between tasks [31].

In particular, multitasking today is much more granular and task switching occurs more frequently in a shorter time [16], [29], [36]. At the core of this change is the universalization of smartphones. Today, smartphones have become a major tool for accessing a wide range of activities and content, and task switching has become a common pattern of smartphone use because one can perform multiple activities [24]. As various functions are added within, the volume of an app increases and advances. The app is not used for one purpose, but the possibility of multiple purposes increases. In this environment, not only switching between apps but also switching within a single app is increasing.

Originally, in MIM, task switching existed between chat rooms from the beginning of service use. However, as the number of messages increases, the number of chat rooms increases, and MIM usage and switching frequency naturally increase [104]. In addition, because photos, videos, emojis, and file transfer functions have been added as well as text-based conversations, the types of tasks that people can do have diversified. Furthermore, in-app task switching is becoming more complex because some MIM apps have recently added functions such as news viewing, shopping, gifting, payment and pay, file storage, food delivery, and scheduling beyond real-time conversation. Due to the COVID-19 outbreak, KakaoTalk, the most used MIM app in Korea, added a QR authentication function [107]. As a result, task switching is taking place at a more microscopic level. However, existing research in the field of task switching in smartphones has mainly focused on application-level switching. Few studies from a microscopic point of view on task switching between various types of use within an app have been conducted.

Therefore, I wanted to conduct a study on the micro-level task switching that takes place within a single app on a smartphone. Through this approach, I tried to understand more concretely and empirically the problems caused by the blurring of boundaries between work and personal areas that are taking place on smartphones due to the continuous switching.

2.2.2 Interruption

In the field of HCI, the problem of boundary collapsing and distraction caused by the mixing of work and personal use on smartphones has been studied from the perspective of interruption as well as task switching [44], [108]–[114]. Modern information work can be viewed as a series of continuously occurring interruptions [115]. The excessive interruptions threaten our ability to focus on one object at a time [116]. The definition of interruption may vary depending on the field or viewpoint, but it can be generally viewed as “suspending with the intention of returning to the original work and completing it” [117]. The main point here is that an interruption does not mean the user has completely abandoned the job, but rather they intend to do something else for a while and then come back. For example, under this definition, when a person checks a message while writing a document, the behavior implies the intention of checking the message briefly and returning to the document, rather than completely terminating the document and checking the message. In addition, Puranik et al. [28], through a meta-review of 247 studies conducted on work and task interruption, revealed that unexpected suspension and interruption of work in progress is accepted as the definition of work interruption. Through this, it can be seen that “unpredictability” can be included in the universally accepted definition of interruption. Taken together, interruption can be said to (1) occur when the current operation is interrupted by an unexpected cause, (2) presume the intention of returning to the original operation, and (3) suspend the existing operation for a while.

Research on the concept of interruption has a long history beginning in the 1920s, when Zeigarnik and Ovsiankina studied it [118], [119]. Zeigarnik [120] revealed that people remember the details of the work they failed to complete better because of the interruptions, and she explained that this was due to unsatisfactory needs for the work. In other words, a person's intention to complete his or her work affects memory. This was established as the Zeigarnik effect. A follow-up study of these results revealed that users tend to try to complete tasks that have been suspended because of interruption [119]. Since then, research on the ways interruptions affect work (e.g., regarding aircraft control and aviation accidents) has been conducted. Gillie and Broadbent [119] studied interruption in a computer work environment. They studied the effect of interruption on computer-based tasks and found that similarity between existing tasks and interruption factors had a greater effect than factors such as task length and controllability [119].

As daily media use and notifications increase due to the generalization of smartphones, studies on interruptions due to smartphones and their negative effects have been conducted [86], [121], [122]. According to a 29-hour study of use behavior for people proficient at mobile phone use, study participants experienced an average of more than four interruptions every hour, and 40% of them did not resume their existing work immediately after the interruption [123]. Lindstrom explained the problem of technology-induced interruption through a diary study of its use by college students. She said users are more likely to experience distractions and disrupt their activities in the process of repeatedly checking for notifications that are constantly arriving [36]. In addition, interruption not only affects work behavior, but can also affect mental conditions such as user's concentration and cognition [26], [28]. Studies have also reported that when users are interrupted by notifications while working, stress and anxiety increase, and they can feel time pressure [124], [125]. Alternatively, studies have revealed the positive aspects of interruption, such as providing an opportunity for rest for relaxation during work [28], [118].

Interruption and Task Switching

Interruption and task switching are common in that they describe a multitasking situation in which a plurality of different tasks are performed simultaneously, but there is a difference in terms of the specific situation of multitasking. Interruption has a main task, and other tasks are considered an obstacle to it. For example, when a user checks a message while writing a document, writing the document is the main task and checking the message is a factor that causes interruption. In addition, as described above, users think that they are writing a document rather than thinking that they are doing two tasks (i.e., writing a document and checking messages), because they think that they will return to writing the documents again after checking messages for a while. In other words, in this case, the user does not deviate from the intention and goal of performing the previous task and considers that he or she is doing something different for a short time with the intention of returning to it [27], [28]. As a result, from a multitasking point of view, interruption can be said to be a concept related to a sequential multitasking situation [25], [26]. However, task switching is a concept that describes the switching situation between two or more equivalent tasks, rather than in terms of the main task and the disruptor. That is, it describes a state in which one is pursuing two or more goals at the same time [26] (Figure 5). For example, the concept describes a situation in which one is working on a messaging app while writing an email, listening to music, or writing a document at the same time. In other words, task switching can be said to be a concept related to a concurrent multitasking situation from a multitasking point of view [25], [26].

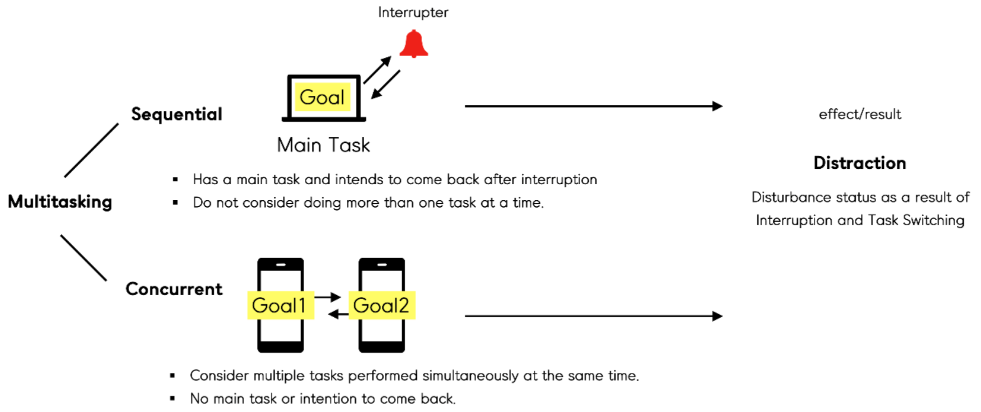


Figure 5 Interruption and task-switching concepts

In this background, it can be said that the phenomenon under study of this dissertation is closer to task switching than interruption. This paper deals with the frequent switching that occurs while the user pursues various tasks at the same time on a smartphone and the resulting blurring and distraction problems. Therefore, it is not multitasking in the form of interruption in which one side becomes the main task and uses a smartphone for a while in the process of performing the task, but in the form of pursuing multiple purposes at the same time (checking work mail while watching YouTube). This phenomenon was analyzed from the perspective of task switching related to concurrent multitasking situations (e.g., switching between a work chat room and a personal chat room at the same time).

Interruption and Distraction

Researchers have different views on the conceptual relationship between distraction and interruption in task performance. According to Puranik et al.'s [28] analysis of 247 studies in the field of interruption, the relationship between the two concepts can be broadly classified into two positions. From the perspective of considering the two concepts separately, interruption means the suspension and cessation of the existing main work behavior, and distraction means the weakening of attentional focus [28], [126]. According to this point of view, for example, if the user's concentration is disturbed by a notification while writing a document, but the document writing continues, this is not an interruption but a distraction. On the other hand, from the perspective that distraction overlaps with interruption, when attention is switched, a problem such as poor performance of the existing main task could occur, so even if the work continues on the surface, it is interruption [28], [127], [128]. Summarizing the two views, distraction refers to a state in which attention is distributed for some cause regardless of whether work is suspended. That is, it is an influence and result according to the situation in which a plurality of tasks occur. From this point of view, this study aims to examine distraction due to problems that occur because work and personal use occur simultaneously within smartphones. A detailed conceptual exploration of this is described in Section 2.2.3.

2.2.3 Digital Distraction on Smartphone

The meaning of distraction is, "A thing that prevents someone from giving full attention to something else." Agrawal et al. [11] defined digital distraction as a distraction from concentrating on the main task being performed by an electronic device or medium. The concept of distraction is often described in relation to multitasking. This is because, in cognitive psychology, multitasking is viewed as a distraction from the point of view that attention is diverted rather than divided [108]. Even looking at previous studies in the field of media multitasking research, media multitasking activities are described as distractive or interruptive [36], [59], [108]. Although digital distraction is often mentioned in the field of multitasking, the definition of the concept appears slightly different for each researcher. Aagaard [129] replaced the descriptive concept of multitasking with "off-tasking" and suggested off-tasking is the same concept as distraction in a normative way. On the other hand, Carrier et al. [130] defined digital distraction as interruptions induced by technology, which is viewed as resulting from daily media multitasking. Lindström [36] noted that digital distraction involves multitasking on digital media, meaning that the behavior is perceived as a problem or a hindrance to a person. Lindström [36] developed a conceptual framework for dimensions of digital distraction, which presents multitasking as one of the four main key theoretical concepts, and argued that the concept of digital distraction was introduced to explain the impact of media's disruptive use.

In other words, the concept of distraction already implies that concentration is scattered or disturbed in its definition. In particular, in the case of digital distraction, it can be considered limited to distraction caused by digital devices or digital media, and it is widely used to explain the results of media multitasking. In this paper, I focused on task switching between different areas, especially within smartphone devices, among digital distraction.

Causes of and Problem Situations due to Digital Distraction

Digital distraction has various causes. The stimuli that cause distraction include auditory and visual stimuli such as alerts, phone rings, notifications, and pop-ups. Depending on the response to these stimuli, digital distraction can be classified into two types: external causes and internal causes [36], [129], [131], [132]. In the former, physical stimuli such as sound, notification, and visual cues affect mechanically attractive reflections, resulting in reflexive and unconscious distraction, and in the latter, the user intentionally and actively decides to do off-duty activities. For example, if a MIM app notification occurs while writing an email on a smartphone, then users would be reflexively distracted by it. At this time, there is no problem if the existing task is maintained despite the notification, but if the existing task is stopped by voluntary selection, then it can be seen that a distraction has occurred. As such, the causes of digital distraction are very diverse.

In this paper, the discussion will focus on the distraction of the user's will, choice, and decision, not on the distraction by sensory attention reflection, with particular attention paid to the distraction caused by task switching.

As mentioned in the previous chapter, many users face the problem of distraction and blurring the line between work and personal use due to smartphones. A University of California study found that on average, people today consume three times as much information as people in the 1960s did, and people who are afflicted with this information tend to lose focus [133]. A 2015 report by the Information Overload Research Group found that US knowledge workers wasted nearly 25% of their time processing explosive data streams, costing the economy $990 million annually. For many, this overload has led to addiction and the constant need to check the device while working or studying, which in turn leads to distraction [134].

In the past, digital distraction studies have mainly been conducted from the perspective of media distraction, and the effects of distraction due to television on reading and the effects of listening to music on reading comprehension have been investigated [135]–[137]. Studies have also explored the effect of laptop use on learning in class [22], [138]. Madden [23] argued that the distraction caused by media multitasking disperses concentration and impairs learning ability. In addition, many studies have been conducted on the effect of digital distraction when digital media and digital devices are used in a learning environment [22], [23], [129], [139], [140]. Researchers have also studied the way multitasking and distraction occur in situations in which a smartphone is used while driving and the distraction problem caused by smartphone use while driving [141]–[143]. Studies have been conducted on the effect of distraction from personal smartphone use on communication and patient safety in hospitals in the medical field [114], [144]–[146]. There is also a study of digital distraction in daily life such as movement and conversation. Oulasvirta et al. [147] investigated ways to manage cognitive resources when using a smartphone while moving, and Su and Wang [148] studied the outcome of a person having a daily conversation while using a smartphone in a pub.

Much research on the effect of digital distraction on work has also been done. Mark et al. [44] investigated the effect of distraction caused by multitasking on work concentration and noted that blocking distractions at work can lead to deeper concentration and higher productivity. In addition, Czerwinski et al. [31] showed that information workers struggle with constant switching of contexts and confirmed that they entered a “distraction chain” due to external distractions. Decreased concentration due to digital distraction resulted in lower work performance not only in negotiation tasks but also in general document tasks [149], and studies have found that task switching lowers concentration and facilitates making errors [32], [149].

Of course, distraction not only causes negative effects. Studies have revealed the benefits of distraction [31], [44]. According to Mark et al. [44], the harms and benefits of distractions depend on the context in which they are placed and the time at which they occur. Whether distraction is a hindrance or an advantage may depend on the source of the information, whether it is externally or internally driven, and whether the context is consistent with the current main task, as well as the personality of the individual [44]. However, when looking at the studies conducted so far, concerns about the cost of digital distraction are still valid [1].

2.3. Strategies to Mitigate Smartphone Distraction

Smartphones today go beyond simple communication tools, and they are involved in all aspects of personal life, from work to leisure [2], [43]. Smartphones are already recognized and are used as an essential tool for many people. However, like a double-edged sword, smartphones are not only useful, but also create a problem that blurs the boundary between work and life [7]. In MIM such as Kakaotalk, work and personal conversations take place in parallel, and distracted behavior such as using YouTube or music apps while driving or in a lecture is common in many people's daily lives. This section comprehensively describes various studies that have been conducted in the HCI field to solve this problem.

2.3.1 HCI Research to Support Distraction Problems

As a way to prevent excessive smartphone use and to manage smartphone use at an appropriate level, the HCI (Human-Computer Interaction) field has researched and applied various strategies, such as task-inserting, delivery, blocking, tracking, monitoring, mindfulness, social approaches, and goal-advance [40–43]. These strategies are either indirect ways to induce users to observe and manage their own conditions or direct ways in which service and functional elements directly intervene to manage smartphone use. In particular, Kim et al. [42] classified the latter's direct intervention methods into three types based on a comparison of the value of smartphone use and non-use. The first type is to reduce the value of smartphone use to prevent excessive use. Strategies for creating inconvenience, such as a task-inserting method that allows users to use smartphones only when they perform additional tasks, may be included. The second type prevents smartphone use itself. This type includes methods that block the path through which the user can use the smartphone by setting specific restrictions. The third type increases the value of non-use of smartphones and includes ways to recognize the value gained when a smartphone is not used.

This study classified management strategies in the HCI field based on the existing classification criteria [42]. For a more detailed understanding, I also tried to explore the need for assistive tools in HCI by describing the efforts that users have made autonomously to manage their smartphone use outside of services or systems. Figure 6 shows the classification results.

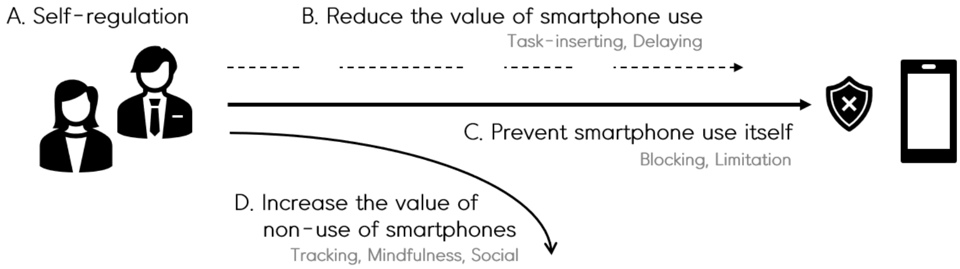


Figure 6 Classification of smartphone management strategy types

A. Self-Regulation

Even without the help of an auxiliary tool, such as a service or an app, many people feel they have a problem with their smartphone use and are trying to manage it autonomously. Users have tried self-regulation, such as putting their smartphones away or setting them in flight mode [48]. This self-management means that the user suppresses the urge to use the smartphone on their own [43]. As self-management is to be the subject of managing one's own behavior, the recognition of each behavior and understanding the motive can be major influence factors. Thus, self-regulation consists of three steps: observing oneself, evaluating the results, and reacting to these [150]. If users apply this process to smartphone distraction, the monitoring process to recognize how much and the way an individual uses the smartphone is the first step in self-regulation. Knowing the status allows an individual to determine whether there is a problem and to apply a suitable solution by making an appropriate diagnosis.

However, autonomous management has a high probability of failure and is difficult, so services or auxiliary tools are necessary [41], [151–153]. As smartphone usage increases, it becomes increasingly difficult for users to understand which apps they use when and how much. In particular, in the case of MIM, the number of messages and types of chat rooms increased due to the convenience of transferring photos or files and the usefulness of group chats [55], [154]. The main characteristic of MIM use is that the user receives notification of messages sent from others. MIM triggers most smartphone notifications [155]. Excessive notifications constantly demand the user's attention [1], [156]. In such a situation, the users' self-management efforts to reduce their usage by themselves are easily frustrated. In this background, researchers in the HCI field have studied various services and functional elements that can help the user's autonomous management.

B. Reduce the Value of Smartphone Use

This type of usage management strategy aims to reduce usage by reducing the value users expect to get from using their smartphones. In this type, specific methods include task inserting and delaying.

Task inserting adds a specific task to the user's app use, so that the user needs to input letters, arrow keys, or numbers to run the app, and researchers have studied whether there has an effect on reducing smartphone usage [42], [157]. J. Kim et al. [42] assigned participants with tasks, such as inputting 30 characters, 10 characters, one button, and so forth to use a web browser, SNS, or entertainment app, and observed whether these tasks had an effect on reducing usage. As a result, artificially creating a "gulf of execution" actually had an effect on reducing usage, and the more complex the task, the greater the effect [42]. Park et al. [157] assigned a task to input a randomly assigned number to run the app and observed the effect, and participants inputted a number with more digits when reuse occurred close to the next use. In this study, task inserting also showed the effect of reducing smartphone use.

Delaying is a way to alleviate the motivation to use a smartphone right away by delivering information late. In relation to notification, researchers investigated a delayed notification delivery method after a user sets a timer or to receive a notification at a specific time [156]. Shin et al. [84] experimented with the notification delivery to reduce excessive notifications arriving from messengers. The researchers tried to reduce the distraction by showing notifications that arrived earlier if no new notifications arrived for 10 minutes. In this regard, researchers sought the optimal notification time [158–160]. Based on actual app usage data (more than 120 million events), Pielot et al. [160] found that communication level, time of day, location, surrounding conditions, and device status were important factors in determining the optimal timing of notification delivery.

C. Prevent Smartphone Use

A strategy that blocks smartphone use actively intervenes to manage smartphone use. This method occupies the highest proportion among the methods used to reduce usage [40], [43]. Even if users do not install them separately, service providers, such as Google and Apple, offer built-in features to block the use of certain apps, such as do not disturb [161] and digital wellbeing [162]. In general, these features block the use of the entire smartphone or a specific app according to conditions, such as the time, set in advance by the user [47], [48], [57], [151], [153]. J. Kim, Jung, et al. [47] created a goalkeeper app, which allowed users to set a weekly time goal through the app and observed the effect by applying three different restrictions when they exceeded the time limit. Each restriction consisted of a weak pop-up notification method when the user reached the time limit, a strong method of blocking all use, and a gradual method of increasing the blocking time starting from one minute, which had a greater effect on usage than a simple notification method. Ko and Lee [48] observed the usage behavior by creating an app that could block smartphone use by group members as a way to reduce smartphone distractions during group activities.

Blocking is the most intuitive and powerful usage management method, but users may feel uncomfortable with strong interventions and restrictions [47], or they may break the set rules and not use the management app [57], [151]. If the user exceeds the time limit but wants to continue using the phone, there is a possibility of deleting the management app or changing the management rules [58]. In addition, it is difficult to block use management in apps that have a combination of essential and nonessential use, such as MIM [151]. Even though MIM accounts for the largest portion of notification, MIM was also the app with the weakest blocking setting [163]. The strategy blocks the disturbing area, as well as prevents essential use. Therefore, there is a need to explore ways to manage necessary and unnecessary uses effectively in a situation where they occur simultaneously in one app.

D. Increase the Value of Non-Use of Smartphones

Tracking and monitoring serve to provide basic information that users can perceive about their usage behaviors. Observing use behavior is essential to the first stage of management [150]. Therefore, it is included in most apps released for smartphone usage management as a basic function of other strategies, such as blocking and limitation [40].

In fact, service providers such as Google and Apple offer tracking and monitoring functions, including screen time and digital well-being, so that people can observe and properly manage their smartphone usage [161], [164]. In addition, third-party providers have released apps that allow users to view their own usage records through the Apple App Store and Google Play Store. Researchers have studied strategies that show the usage time and percentage of each app every day, show the usage density of the app every 5 minutes [165] or develop a self-monitoring system that captures the PC usage and shows that usage through widgets [152].

However, tracking and monitoring strategies only provide data for management. Management effects are difficult to interpret if the user does not see the record or take action. In addition, it is difficult for users to interpret and analyze data unless they have data visualization and semantic interpretation at an appropriate level.

2.3.2 Summary

Researchers have applied strategies to manage smartphone use in the HCI field, including adding obstacles to the task execution stage, delaying the task completion time to reduce the value of use, and monitoring support so that users can check their usage directly. The most intuitive and widely used method was to prevent the interference by blocking the use itself. However, the existing strategy has limitations, as previously described. In the blocking method, the user can bypass blocking by deleting the app or resetting the rules after reaching the preset usage limit. Moreover, given the recent usage environment, in which users frequently switch between work and non-work use in one app, strategies to block the use of specific apps are practically impossible to apply. Considering this situation, this study proposed a method that allows users to prioritize work and non-work areas without blocking either side as a possible management strategy, thereby reducing user switching and contributing to contextual smartphone use.

2.3.3 Strategies for Managing Priorities

Not only are smartphone apps integrated into our daily lives but also the number of devices that use smartphones, such as automobiles and heating and cooling systems, has increased [166]. The amount of information that users check and manage with their smartphones has increased rapidly. In addition, as more work- and non-work-related actions occurred on smartphones during the COVID-19 pandemic, the amount of information processed on smartphones has also increased. According to Deloitte [21], during the pandemic, approximately 70% of consumers initiated a smartphone-based purchase action, such as a mobile order, and more than 50% of US adults used virtual doctor visits. In particular, as users actively use MIM in work and non-work areas due to advantages, such as free file transfer and management and convenient group chats, users have many messages and notifications in MIM [19], [55], [154], [167]. Recently, many Korean companies chose MIM as a major customer-response channel, and MIM providers continue to add additional functions, such as news, advertisements, web toons, and shopping, with more information distributed and processed through MIM [107].

With too many notifications to check, users experience information overload. In particular, the boundary between the two areas weakens as business and personal conversations occur in one app. Thus, I looked at existing strategies for managing messages that occur simultaneously in different areas. By understanding the message management strategy currently used in MIM, I explain the background of the priority-based message management strategy proposed in this study.

Priority Management Strategy

Management strategies, such as filtering and satisficing, have been used as strategies for managing a large amount of information arriving from different areas [168]. Manheim, L. [169] summarized the strategies users take to respond to problems caused by too much information into three categories: (1) escape strategies that end information retrieval early, (2) reduction strategies that limit the overall amount of information exposed, and (3) omission strategies that avoid exposure to unwanted information. Bawden and Roninson [168] described the first strategy as meaning the “satisfying” strategy.

In particular, the need for filtering has increased as the primary management method of information overload [170]. Filtering is a method of distinguishing unnecessary and necessary information according to priority or importance and allowing users to access important information first. Specifically, it can be divided into active filtering, which selects useful information and exposes it first, and passive filtering, which hides unnecessary information [168]. Kim et al. [171] proposed a strategy to filter notifications based on keywords, senders, and arrival patterns by studying smartphone usage behavior and notification based on large-scale smartphone data collected from 81 subjects over 14 weeks. Recently, researchers have studied a way to screen required information automatically based on user data [168], [170], [172–175].

What these strategies have in common is to classify information, such as notification, email, message, and search results, according to necessity and importance, and to provide the necessary information to check first. These strategies can provide a priority setting function, in that they help users check the information they want first. Because users typically want to check important or preferred information first [176]–[178], this approach considers the users’ needs.

Email is the most-actively applied priority strategy service to help users see important content first. With thousands of emails arriving every day, users prefer to read important, urgent, or useful emails first [179]. Setting a filter to prioritize the arrival of excessive information is a key management method proposed in email-related research [180], [181]. In an early study, Marx and Schmandt [173] proposed a prototype of CLUE as a strategy to manage the overflow of emails in business situations, revealing that users who received a lot of mail tended to read the most important messages first. CLUE provides a function that helps users to read important emails based on personal information, such as schedule information, sender, and geographic information. Horvitz et al. [182] proposed a strategy to define the importance of email messages and to prioritize email automatically by giving them importance values based on mail capacity, tense, and schedule information, as well as recipients, senders, and attachments. In recent years, researchers have studied strategies to classify and prioritize email by automated algorithms by analyzing the contents or meta-information data of email messages through systems beyond passive filtering and classification by users [172], [181], [183], [184]. In particular, Yoo et al. [185] conducted a study to classify the importance of messages from the perspective of social relationships through analysis of users' social network information and existing metadata.

As the most commonly used priority management strategy, representative email services, such as Gmail, MS Outlook, Apple Mail, and Yahoo Mail [186], provide inbox filtering and classification through manual labeling by users. In the case of Gmail, users can create text-based labels and use these to create filters. Using filters, users can automatically manage the label of each email and determine whether the inbox is exposed depending on the recipient, sender, keyword status, attachment status, size, and so forth. In addition, the inbox management feature allows users to prioritize exposed mail [46]. Apple Mail does not provide text-based labels, but it allows users to set color-based flags. In addition, similar to Gmail, Apple Mail provides a "Smart Inbox" function that generates rules that automatically classify mail according to conditions such as user-assigned flags, recipients, and sender, as well as attachment status and type. Additionally, Apple Mail allows users to prioritize each email as low, normal, or high [45].

Recently, not only personal conversations but also work conversations have occurred simultaneously within mobile messengers. As various messages arrive simultaneously within one app, users experience frequent switching problems and boundary collapse between different areas. This study attempted to apply priority management strategies, as discussed in this section, to alleviate the switching problem within MIM apps.

Message Management Strategies Provided by Mobile Messengers

To propose a message delivery strategy to manage the switching problem within MIM apps, this section describes the message management strategy already provided by the messenger.

Mobile messengers provide some functions to help users reduce exposure to unnecessary messages and to help users see necessary messages first. Based on the Monthly Active User [186] and Google Play Store communication app rankings [187], the message and notification management functions provided by the most commonly used messenger apps and business messengers are summarized (Table 1, based on the app version as of June 24, 2022). A function commonly provided by messengers for message screening is to turn off notifications for each chat room. The notification management function provided by almost all apps allows users to turn off chat-room notifications that are of low importance, so that users are not exposed to these conversations. However, as most of these functions only prevent notifications from occurring, there is a limitation: the contents of all unchecked conversations and the existence of notifications are exposed when running the app and checking the conversation list. Conditional notification is a strategy to manage notifications according to conditions without blocking all notifications in each chat room. Mention (user designation) is a condition that is often used. The user can receive a notification only for the message referred to by the user, or they can the content separately. In addition, there are conditions in which users are notified about messages using specific keywords or notifications are received only in a specific period or in a specific state (connected, etc.). The top pin feature is a strategy that allows users to place the chat rooms they think are important at the top of their conversation list. This strategy helps to prioritize the contents of the fixed chat room by first making it visible. The hide function prevents exposure to the chat list until a new message arrives in the chat room, but users can view the chat list when there is a new message. As another strategy, Facebook Messenger provides an ignore feature. Ignore is a blocking feature that allows the sender to send a message, but the recipient does not see the chat room on their list, and notifications of new messages do not work. Telegram hides the badges for each chat room when new messages arrive.

However, the priority function currently provided by mobile messenger manages new message notifications in chat rooms, unlike email label classification and filters. In the case of email, as described in the previous section, priority exposure or archiving is possible depending on the conditions, such as content or sender/receiver. However, in MIM, even if the user turns on notifications for a specific chat room, once the user launches the app, all chat rooms are exposed in the chat list. In this case, the effect of setting the priority may decrease. In addition, as described in Chapter 1.1, the recent work environment is not separated clearly, unlike the previous 9 to 6 model, in which work and personal time were separated. Users use their cell phones for personal reasons when they are not busy at work, and they receive work messages when they have something important to do after work. In this situation, the turn-off function for chat room notifications provided by

MIM may increase the user's inconvenience and lower the motivation for using this function. For example, it may be useful to receive only business-related notifications during a business meeting, but immediately after the meeting, users may want to check their personal messages. The current functionality is inconvenient because users have to change the chat room priority or the notification settings for every situation. In the case of keyword notifications or user mentions, users can receive unwanted notifications because they often operate in chat rooms where notifications are turned off. In addition, as it is a function applied to the incoming message, the message cannot be managed according to the user's desired priority.

App name	**Message management strategy**				**Other Strategies**
	Turn off Notifications	Conditional Notification	Top Fix	Hide	
WhatsApp	**O**	**O**	**O**		- Reaction Notification
WeChat	**O**	**O**	**O**	**O**	
Facebook Messenger	**O**	**O**			- Ignore notifications
Telegram	**O**	**O**	**O**		- Hide Badges
Kakao Talk	**O**	**O**	**O**		
Line	**O**	**O**	**O**	**O**	
Discord	**O**	**O**	**O**	**O**	
Slack	**O**	**O**	**O**		
Jandi	**O**	**O**	**O**	**O**	
Dooray	**O**	**O**		**O**	
Flow	**O**	**O**	**O**		

Table 1 Message management strategies provided by major MIM services

Against this background, this study tried to propose a new function based on the contents and functions of the existing message priority management strategy (Chapter 5). First, I borrowed the email filter strategy to solve the problem of the existing strategy in which all chat rooms are exposed on the list, not just the chat rooms that the user has set priorities. In the case of email, it is possible to set a filter by label, so that only specific emails are exposed. Utilizing this, this study proposed a temporal priority strategy that requires users to check priority messages first in order to check non-priority chat rooms in the list. In addition, I proposed a delivery strategy that allows users to check the content of a priority conversation by borrowing the top-fixed priority strategy previously used in email and MIM.

2.4. Mobile Multitasking and Switching Research Approach

Existing studies on smartphone usage behavior and application switching mainly utilized one or more of three methods: survey, diary, and application log analysis. Freyne et al. [188] analyzed app usage data to investigate how smartphone push notifications and app messaging services affect user engagement and Lee and Shin [189] analyzed daily app session times and daily purchase activity for targeting potential active users. Even though for quantitative analysis of smartphone usage behavior, studies have employed several approaches, including smartphone on/off hours [190], tracking battery usage for each app [191] and network activity analysis (network activity) [192], the most widely used approach is app usage pattern analysis [193]–[195]. Böhmer et al. [193] conducted one of the largest-scale investigations on application running patterns. They developed and released software to collect an application-launching log and then collected the log from 4,100 users.

To analyze usage patterns meaningfully, several studies compiled descriptive statistics about individual application logs and defined and analyzed a “session.” Böhmer et al. [193] found that the average session with an application lasts less than a minute, even though users spend almost an hour a day using their phones. Further, users spend less than 72 s with an app at a time. Ferreira et al. [196]

examined a smartphone-application usage pattern referred to as micro-usage, i.e. brief bursts of interaction with applications. They identified the short period from launching an application to exiting it, which is referred to as an application session.

The problems of existing studies on application usage pattern are difficult to understand in users' context. Numerous studies have analyzed application usage patterns. Even though these studies allow for the generalization of results and make it easy to understand overall application usage and behavior in the macro perspective, it is difficult to understand them extensively considering users' context. Although numerous precedent studies reported large-scale application usage, they did not investigate its contexts, including reasons and purposes [193], [197]. Ferreira et al. [196] used the ESM method to determine the context of use; however, there was a limit to the choice that could be made only among the options provided by the researcher. To overcome this limitation, I collected and analyzed more detailed contexts such as work schedule, hours, purpose of use, and log data.

3. Between APP Switching Behavior:

Study of Work and Non-work APP Usage Pattern

In this chapter, I describe the results of RQ1 (How do users use smartphones differently depending on their work and non-work situations?) and RQ2 (What is the extent of users' mixing of smartphone usage between work- and non-work-related usage and in what ways do they mix their use?). This study was conducted to understand the macroscopic landscape of how users use their smartphones for work and non-work purposes in the context of work and non-work situations, as the beginning stage of a series of continuous exploration leading to chapters 4 and 5. Following this background, this study analyzed users' smartphone usage behavior according to work and non-work situations and switching patterns between work and non-work usage using log data automatically collected in the actual field. In this study, the use for ‘work purpose’ and ‘non-work purpose’ refers to whether each smartphone use is a work-related use or not. For example, reservation of a business meeting place can be seen as a work-related behavior, although it is not a work itself. Through this analysis, I revealed that the use of work and non-work purposes on smartphones is being mixed close to chemical fusion beyond simply separable physical levels in terms of frequency and content, and raised the need to deal with work-related smartphone use at micro-app usage levels. In particular, the studies introduced in this section revealed the need for research on switching between work conversations and personal conversations by explaining that work-related and non-work-related uses occur most in MIM. It also observed the need to focus on the use of micro-level switching within a single app called MIM. These results became a key motivation for conducting a conversational switching study in MIM in Chapter 4. The research contents of this chapter have been submitted and published in '*International Journal of Human-Computer Interaction*' [198].

3.1. Motivation

In the conventional nine-to-five working model, people worked only in their workplaces. Typewriters remained on desks, telephones were wired, and computers were not portable. However, currently, working is not limited to specific hours and locations [9]. With the advent of mobile devices, smartphones have enabled people to perform work activities anytime and anywhere [199]. Smartphones enable us to perform work and diverse activities simultaneously. We can listen to the latest music, check e-mails, and search for a hotel close to our destination while riding on subways. According to a Google mobile apps report [200], the everyday use of smartphones has become a habit. Moreover, diverse applications, including games, entertainment, news, and sports, are being used in numerous places and at various times simultaneously. In addition to the technological benefits, a few problems that were non-existent earlier have arisen. As work and leisure activities are handled by one device—the smartphone—the boundaries between both domains have diminished. This has led to social problems and an increase in the negative consequences on work-life balance [2], [5], [76]. In the office, cyberslacking, which is defined as the use of smartphones during business hours for unrelated purposes, is increasing [37]. The problem of engaging in work-related phone calls during leisure time has also been occurring. In particular, as Korea has the highest smartphone penetration (88% in 2017) [201] and more working hours (2069 hours per person in a year) [202], it can be inferred that large portions of working hours and smartphone usage time overlap. In this regard, in Korea, life without leaving the office and logging out has been discussed as a major social problem that causes stress. In response, there is ongoing debate on the "right to disconnect." As the boundaries between work and leisure domains have blurred, people are compulsorily resorting to routine multitasking—in which several tasks are performed simultaneously. This consumes a user's cognitive ability [22]. Furthermore, according to the motivated cognition model [203], a user is like a student postponing homework and messaging his/her friend. Hence, problems arise because tedious activities are postponed as the user tends to select preferred activities while multitasking [22].

Existing studies have focused on explaining self-regulation failures and media addictions including smartphones, which cause these problems [204], [205]. According to such studies, the blurred boundaries between work and leisure domains can be solved by banning smartphone use and improving self-regulation. Oulasvirta et al. [204]pointed out that people acquire the habit of checking their own devices repeatedly and referred to it as mobile data service addiction. Rosen [206] suggested that smartphone addiction is a mental disorder that requires treatment. In this respect, behavioral problems such as smartphone addiction, and cyberloafing/cyberslacking should be mainly solved through self-regulation, including balance and control.

However, considering that working environments and smartphones are linked closely, reducing smartphone use and blocking it at the individual level is not a realistic solution. We rarely have a chance to live without technologies—they are woven into the fabric of our lives [4]. Even though smartphones are interfering with work and impairing work-life balance, their availability is increasing every day. People are accustomed to performing work through a virtual office [15], which saves all their data and work tools to an intermediate space, such as a cloud drive, connects the space with their smartphones, and performs work.

Therefore, for current business realities, there is a requirement to find new alternatives to solve problems resulting from smartphone use in the work and leisure domains. For this purpose, a practical study should be conducted on the current use of smartphones in these domains. Based on this background, the aim of this study is to analyze the following problems on the manner and purpose of current smartphone usage in actual situations and to deliver solutions through a survey:

RQ1. How do users' smartphone usage behaviors differ according to work and non-work situations?

- How do people's smartphone usage time and density, as well as the apps they use, differ according to work and non-work characteristics?

RQ2. What is the extent of users' mixing of smartphone usage between work- and non-work-related usage and in what ways do they mix their use?

- In work and non-work situations, what is the extent to which the mix between work use and non-work use appear, and what is the transition pattern?

In this study, users’ smartphone usage logs were collected and analyzed to understand their usage more specifically and practically. In comparison to the existing studies on smartphone usage, which mainly focus on surveys [8], [9], [75], [207], [208], this study is an attempt to practically analyze smartphone usage by examining the log data recorded automatically whenever users use their smartphones. This minimizes the misinterpretation of data that may occur when relying on users' memories.

The collected log data were divided into several sessions. Behaviors were classified into the following four types: non-work-related behaviors during work time, work-related behaviors during work time, work-related behaviors during non-work time, and non-work-related behaviors during non-work time. Then, depending on these behavioral types, the types of applications, the timeslot-based and day-to-day usage rate, switching rate, and pattern were analyzed.

3.2. Study Design

In this study, I examined the application type and its purpose of use during work hours and non-work hours. To achieve this, the following three activities had to be carried out: First, I required the actual smartphone usage history for each user. Second, I needed to collect purpose information about whether the recorded history concerns work or not. Finally, I needed information about whether users use smartphones during work hours. To obtain this information, I collected the smartphone usage log, which was automatically recorded for each user. Furthermore, the usage log was produced in the media diary format, and I asked each participant to tag the relevance of the collected log to work. Additionally, data properties were analyzed through a survey by checking each participant's work schedule.

Study participants were recruited through paid advertising on Facebook, online/offline announcement in the universities of Korea, and posts on an Android social networking community in September 2017 for two weeks. As there are limitations in that the app logger used in this study could operate only on Android smartphones, the participants were limited to Android users. Also, I wanted to conduct a study on knowledge workers who mainly handle their work with PCs, and since the purpose of the study is to observe and analyze the patterns in which work and personal activities are mixed within the smartphone, the current smartphone can also be used as a work purpose. I recruited people who were using it. This study recruited subjects through several screenings. First, all the subjects were recruited as people who were working for a wage. The second condition was those who currently use smartphones for work. Twenty-one participants' logs were collected, three of them were removed during data collection, and consequently, 18 subjects participated. I recruited two subjects in their teens, ten subjects in their 20s, and six subjects in their 30s; 11 participants were students and seven were workers. All student participants had a part-time job or had participated in research project work.

3.2.1 Data Collecting

First, I instructed participants on the installation and setup of the app logger at the pre-stage. I used Automate (developed by LlamaLab) to collect their log data. Participants' smartphone logs were collected by a foreground app logger, which is one of the add-on features of this application. After installing and testing the logger for 24 hours, I verified that logs were collected normally, and then, the experiment was conducted. In addition, the demographic information of participants, including age and occupation, was collected through an online survey at the pre-stage. Participants were asked for their informed consent to their willingness to allow for the collection and use of their personal information after providing guidelines for data to be anonymized. App logger automatically recorded the sequences of time stamp and application name when conducting interactions, including user actions such as turning an app on, pushing a button, and clicking a menu. These log data for each participant were collected for four days (exactly 72 hours). Participants were divided into three groups because the researchers had to produce the diary within hours based on the log data collected on that day. I collected the data one group at a time, and then proceeded to the next group in turn. Thus, each participant participated in only four of the weeks; however, data were obtained for all days. In the process, I adjusted the number of participants active on particular days to prevent data collection from being concentrated on a specific day of the week.

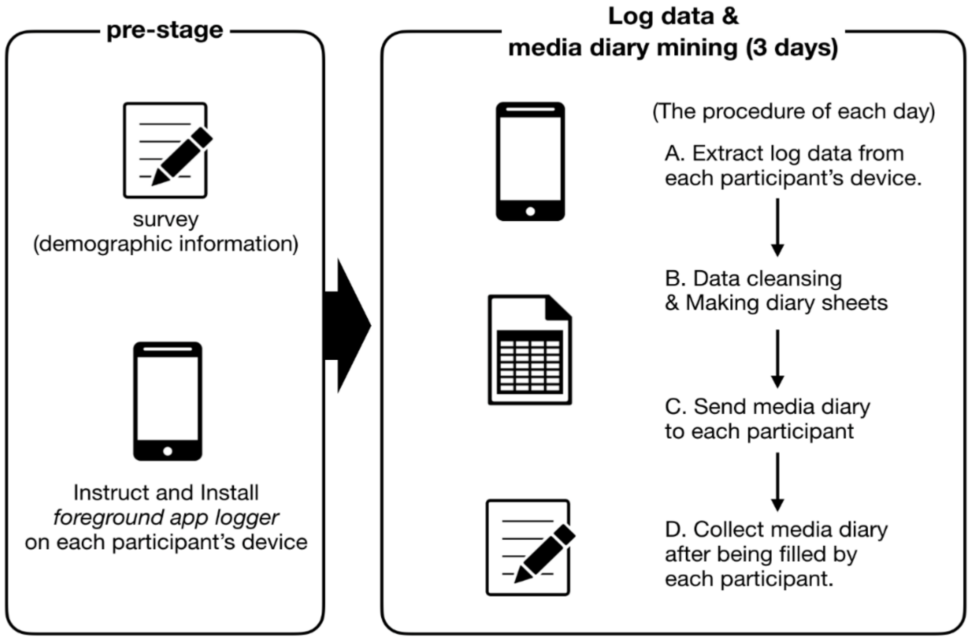


Figure 7 The Process of Data Collection and Cleansing

To classify the log data into work-related and non-work-related behaviors, participants were asked to tag the data by relevance to work for each behavior. After collecting and cleaning automatically generated logs, I created a diary, which enabled participants to record their events and whether each event is relevant to work-related behavior. Cleaning was performed by carrying out the following activities: (1) Change of application name from English to Korean. (2) Deletion of the logs automatically recorded by the smartphone's OS. (3) Using Microsoft Excel to enter the tag. To minimize memory distortion or oblivion while tagging, I received log data at noon each day. In addition, to minimize the gap between the times of recording the log and tagging behavior, I sent the diary to each participant at 6 p.m. on the same day. In addition to log data, I collected daily work hour information through an online survey.

3.2.2 Data Processing

The final data collected from the foreground app logger and participants' tagging consisted of the application name, time of starting interaction, and characteristics of work (work-related, non-work-related, and forgotten). To analyze sequentially recorded data, I referred to the study of Meyer et al. [209] to analyze the usage logs of the personal activity tracker; subsequently, the data were categorized based on sessions. I set a certain amount of time of no interaction with the smartphone as a "break," and the collected log data were divided into sessions and streaks depending on the length of the break (2-5 minutes and more than 5 minutes). The diagram of the specific classification method is shown in Figure 8.

A break does not contain a newly recorded interaction for a certain time after recording a user's event. Depending on the length of the gap in the log, I classified breaks into long breaks (>5 minutes) and short breaks (2–5 minutes). Based on this, all log data were classified into sessions and streaks.

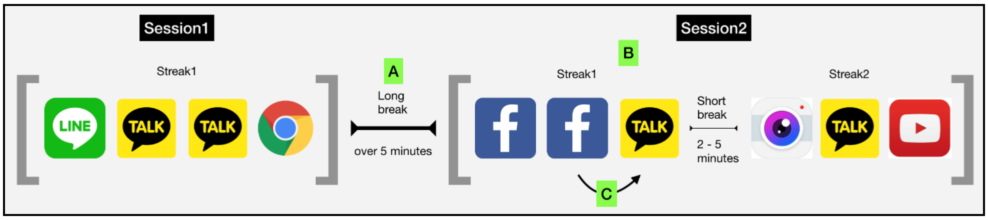


Figure 8 Visualization of smartphone usage session including streak and break

I referred to the study of Jones [194] to set a specific reference time for a break. In the study, they found that the peak re-visitation rate was 5 minutes. Based on this, I set 5 minutes as the reference time of a long break. When the time gap was more than 5 minutes in the time stamp of the usage log, I assumed that the user shifted from a previous usage session to a new session. In other words, a session implies that a participant uses a smartphone without a time gap (more than 5 minutes). The session is terminated by a long break.

The short break was set to analyze more specific smartphone usage behaviors. A streak is terminated by a short break, in which a user interacts with an application without a gap of more than 2 minutes. This is classified as a short break in the log. A short break implies that users stop using their smartphone for a while, but the session is not terminated completely. Jones et al. [194] showed that the average application-usage session is 72 seconds. Based on this, I set the period of 2 to 5 minutes of no interaction with an application in a session as the short break.

I created sessions based on a break, as shown in Table 1. van Berkel et al. [210] proposed another method of dividing sessions by grouping sequentially recorded events into average continuous times of application use referred to as the threshold. To verify whether there are differences between the results of this study and van Berkel's method, I analyzed the continuous usage time (45 seconds suggested in the study) of the second session for each application. Accordingly, when analyzing a session after grouping the application log with the 45 seconds threshold, there was no difference in the overall session distribution to be changed. The total numbers of sessions and their proportions associated with work showed that the maximum difference was 0.6%, up to two decimal places. Consequently, I determined that the session analysis based on the break has no problem and conducted the following analysis in accordance with the existing method.

	Description
Session	It is a smartphone usage section that consists of streak(s) and short break(s), which is terminated by a long break (>5 minutes).
Streak	It is a smartphone usage section that is assumed to continuously use a smartphone by a user, while a user turns a screen on once. It is separated by a short break (2~5 minutes).
Event-chain	It is a smartphone usage section that is grouped into similar events with same characteristics of business (type) in one streak.
Event **(**Individual **log)**	One individual data among logs automatically recorded by App Logger, which means a user directly interacts with smartphone. (Including launching application, opening menu, pushing button, and other interactions)
Long break	Interval (gap) between sequential launching time for two applications is more than 5 minutes.
Short break	Interval (gap) between sequential launching time for two applications is more than 2 minutes and less than 5 minutes.

Table 2 Description of Terms and Measures

3.2.3 Data Analysis

Based on the previous data processing, as shown in Figure 8, the log data for smartphone usage collected by each participant were classified into sessions, including short breaks and streaks. Additionally, I analyzed specific information for each session while generating a session matrix using the VBA macro function in Microsoft Excel.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	id	P	session no.	day	date	start time	end time	duration	interaction log	density	streak	break(s)	switching	NWatW	WatW	WatNW	NWatNW
2	1	1	1	MON	2017-09-04	12:00:53	12:14:05	0:13:12	69	0.08712121	1	0	19	0	0	3	66
3	2	1	2	MON	2017-09-04	12:19:35	12:27:04	0:07:29	21	0.0467706	1	0	8	0	0	0	21
4	3	1	3	MON	2017-09-04	12:33:08	12:37:58	0:04:50	13	0.04482759	2	1	6	0	0	0	13
5	4	1	4	MON	2017-09-04	12:43:47	13:03:03	0:19:16	63	0.05449827	2	1	20	0	0	4	59
6	5	1	5	MON	2017-09-04	13:08:03	13:51:48	0:43:45	120	0.04571429	5	4	31	0	0	0	120

Figure 9 Characteristics of log data

Next, I revealed smartphone usage patterns in the analysis stage. To analyze how and what amounts of work-related and non-work-related usages were mixed, I classified sessions and streaks by utilizing the diary data for work schedule and each event. I performed data analysis in the following three areas:

1) Categorizing types depending on relevance to work

Through the survey, I classified the entire session into four types depending on work-related properties using diary data, which contained usage purpose and work schedules (work hours and non-work hours). Each type of session is referred to with its abbreviation, as shown in Table 3. To categorize each session including different types of events into one type, one of four types was given for each event in each session; then, I defined the representative type that had the largest number of types in a certain session. In this process, I excluded the event that was marked as forgotten.

	Work hours	**Non-work hours**
Work-related purpose	WatW: Homogenous Session that is recorded as working hours and has the largest number of events to use smartphone for work-related purpose.	WatNW: Heterogenous Session that is recorded as non-working hours but has the largest number of events to use smartphone for work-related purpose
Non-work-related purpose	NWatW: Heterogenous Session that is recorded as working hours but has the largest number of events to use smartphone for non-work-related purpose	NWatNW: Homogenous Session that is recorded as non-working hours and has the largest number of events to use smartphone for work-related purpose

Table 3 Session type by work condition and purpose of use

Additionally, in these four types, I classified the session in which a smartphone was used for the matched purpose with a certain schedule as a homogenous session (WatW and NWatW sessions). I classified the session in which a smartphone was used for the unmatched purpose with a certain schedule as a heterogeneous session (WatNW and NWatW sessions). Further, for more specific analysis, I performed streak classification in each session in a similar manner. Thus, I classified four types of streaks, which were divided into heterogeneous and homogenous streaks.

2) Analysis of application type and usage pattern depending on characteristics of work

The types of applications recorded in the log were analyzed for the contents of users' smartphone usage related to work activities. These types were grouped into 11 categories according to the names recorded by the app logger. This was carried out in two stages. After checking the classification criteria of the Google Play Store applications, they were first divided into 23 categories and then into the following 11 categories depending on their similarity by two professional researchers: communication, mobile instant messenger (MIM), SNS, web browser, education/information, entertainment, photo/camera, finance/shop, health/lifestyle, map/navigation, and productivity. However, the MIM category, which is similar to communication, was separately classified for specific analysis because its usage is higher than that of other categories.

I found the application categories that are likely appear at once in one session and performed clustering on them. For this purpose, the probabilities of frequency to be contained in the application category for each session were calculated. In the next stage, to classify a unique pattern of application usage for each session, a log session sequence (LSS) was defined as a new value that indicates the application sequence. I calculated the probability that the applications in 11 categories are transited to another 11 categories (11 × 11 = 121) and created a transition matrix. The probability for one event was counted considering only the case that is shifted from the immediately preceding event to the immediately succeeding one. I calculated the total probability (PPS) by multiplying all transition probabilities for all events included in each session. The unique value of the sequence probability (LSS) for each session was calculated after applying the logarithm.

The values calculated from the previous two processes were the frequency probability of occurrence for each application and LSS. I performed clustering using these two values for each session. To prioritize the cohesion for each factor, clustering was conducted by employing the K-means clustering method. SPSS (Ver. 23, IBM) was used for analysis.

Lastly, to analyze the relationship between the probability cluster of application categories derived from the previous process and the four types of sessions, I conducted cross-tabulation analysis for two clusters to examine whether each cluster was grouped and distinguished relevantly.

3) Switching behavior analysis

To observe the degree of mixing of work-related and non-work-related behaviors, I analyzed participants' switching behaviors recorded in the smartphone usage logs.

For the observation of switching behaviors, I focused on the switching between event chains (1, in Figure 10) rather than sessions. Through this, I tried to analyze the switching behavior between work purpose use and non-work purpose use at a microscopic level. The switching between sessions or the switching between the stricks in a session is in a relatively macro range, and the use of work and non-work logs are mixed in each session and strick, so there is a limit to analyzing the switching based on this. Therefore, I tried to observe specific switching behavior at a more microscopic level by looking at switching between each event chain bound by usage logs for the same purpose within a session.

I analyzed event patterns by the proportion of the four types (NWatW, WatW, WatNW, and NWatNW) in each streak and sequence. These results can show how often and in what pattern a user switches between work and non-work behaviors in a series of smartphone usage. To analyze the results, I classified the events in the same streak into the same type sequentially and grouped them by the event chain. Then, I generated and analyzed the matrix of characteristics for the number of chains and switching, sequence of switching, and its ratio in a streak. Based on the results, I analyzed all streaks by setting the code according to 1) the type of the first event chain, 2) the switching pattern of the event chain, and 3) the proportion of the event chain. Three experts in the field of human–computer interaction provided the primary code depending on the three properties and structured its pattern by providing the final code through cross validation.

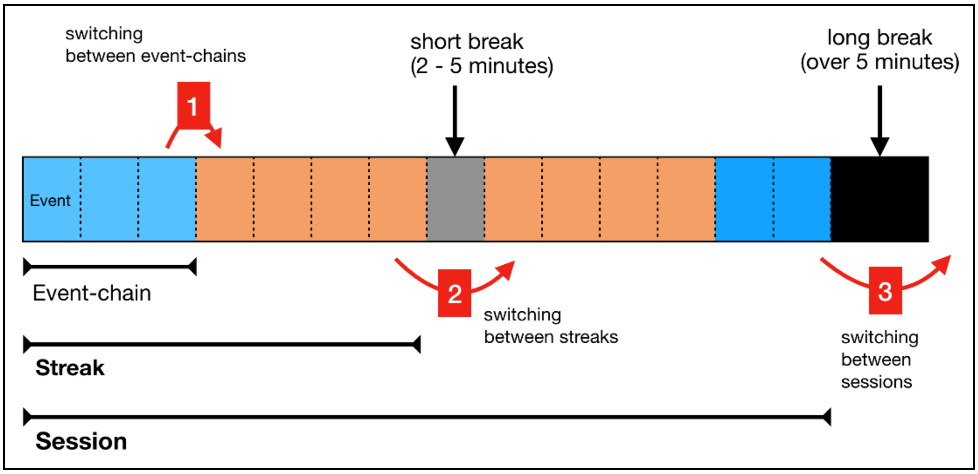


Figure 10 Visualization switching types by level

3.3. Results

3.3.1 Quantitative observations

	NWatW	WatW	WatNW	NWatNW	F/P (Dunnett)	Total
Number of sessions (The ratio of each category among total session number)	477 (24.78%)	182 (9.45%)	106 (5.51%)	1160 (60.26%)		1925
Number of streaks (The ratio of each category among total steak number)	848 (26.61%)	280 (8.79%)	164 (5.15%)	1895 (59.46%)		3187
Sessions longer than 5 minutes (Percentage within that category)	178 (37.32%)	49 (26.92%)	26 (24.53%)	393 (33.88%)		646
Sessions longer than 10 minutes (Percentage within that category)	97 (20.34%)	24 (13.19%)	10 (9.43%)	218 (18.79%)		349
Total usage time (Seconds, The ratio of each category among total session number)	192567 (27.2%)	47889 (6.8%)	24084 (3.4%)	444415 (62.7%)		708955
Average usage time for each session (Seconds)	403	263	227	383	3.884 /0.009**	368
Average streak within a session	1.76	1.51	1.47	1.66	2.698 /0.044*	1.66
Average break within a session	0.90	0.66	0.58	0.77	Not significant	0.78
Average switch within a session	5.46	3.14	2.98	5.55	5.086 /0.002**	5.16
Average event within a session	26.90	12.12	13.28	24.77	3.895 /0.009**	23.47

Table 4 Description of session group

From each of the 18 participants, 45,398 events were accumulated through the collecting diary in the log data over 72 hours. For each subject, the minimum log collection was 824, the maximum was 8440, the median was 2051.5, and the mean was 2522.1. Through data cleaning and processing, the collected data were categorized into four types based on work-related characteristics, as shown in Table 3. All four types of sessions lasted for an average of 368 seconds, with an average of 23.47 logs, 1.66 streaks, and 0.78 breaks. In addition, there was an average of 5.16 switches in each session. The NWatNW group occupied the highest proportion (60.26%), and WatNW was the lowest at 5.15%. To prove significance of group distribution, a one-way analysis of variance (ANOVA) test was performed on each group feature. The results showed that the length of a session and the average number of streaks, switches, and logs contained meaningful differences, except for the average number of breaks for each session. Similarly, the streaks in each session were categorized into four types. In these streaks, the largest percentage was of NWatW, followed by NWatW, WatW, and WatNW.

The total use time of each group was in the order of NWatNW (62.7%, SD=662.81), NWatW (27.2%, SD=741.68), WatW (6.8%, SD=420.81), and WatNW (3.4%, SD=390.74). The trend of the overall distribution was not significantly different from the distribution of the number of sessions. That is, there was no change over the tendency that the use time was short even when the number of sessions was large, or the total use time was rather long even though the number of sessions was small. However, in the detailed analysis, a special point appeared. When the average length of sessions belonging to each group was examined, NWatW was the longest (403 seconds). The number of sessions that lasted more than five minutes was the highest, accounting for 37.32% of NWatW (in terms of percentage of sessions in this group). In addition, the number of sessions lasting longer than 10 minutes was the highest with 20.34% of NWatW. In other words, the non-work smartphone use during work hours tended to last relatively longer than other types of behaviors. NWatW also showed the highest values for the number of streaks / breaks / events.

3.3.2 Weekly and daily distributions

The probabilities of weekly and daily occurrences in the four types were analyzed. Because work and leisure are closely connected with office hours regulated by society, I determined that the analyses of their distributions and occurrence probabilities were meaningful to compare their general characteristics for the four groups. Figure 11 shows the probabilities of different sessions at hourly and daily intervals by connecting them in a line.

P(A|B), A: NWatW, WatW, WatNW, or NWatNW. B: Total numbers of sessions

According to the distribution of weekly sessions derived from the calculated values of probability, NWatNW showed the highest proportion on all days. As shown in the detailed trends, two sessions of NWatNW and NWatW related to the non-official session degraded from Monday to the following days. Conversely, the WatW session (work-related smartphone usage) showed higher rates on Wed/Thu/Fri compared to Mon/Tue. Thus, from Wednesday as a starting point, work-related usages increased, and non-work-related usages decreased. It was observed that WatNW indicated low overall probability, while it showed relatively higher probability on Mon/Tue/Weekend in comparison with Wed/Thu/Fri..

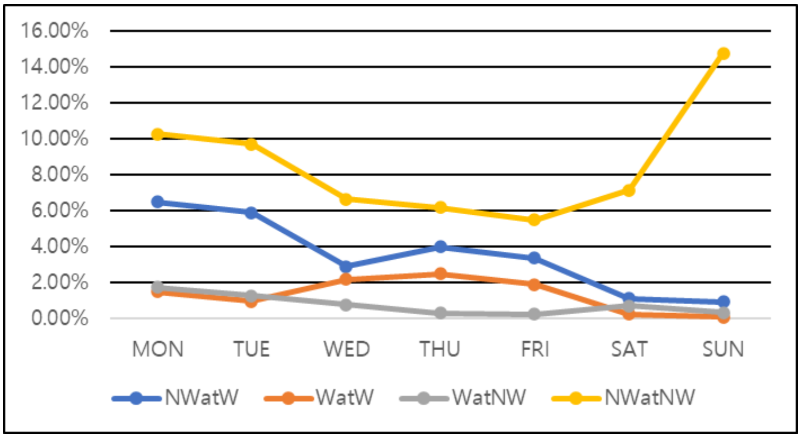


Figure 11 Probability of occurrence of session by day

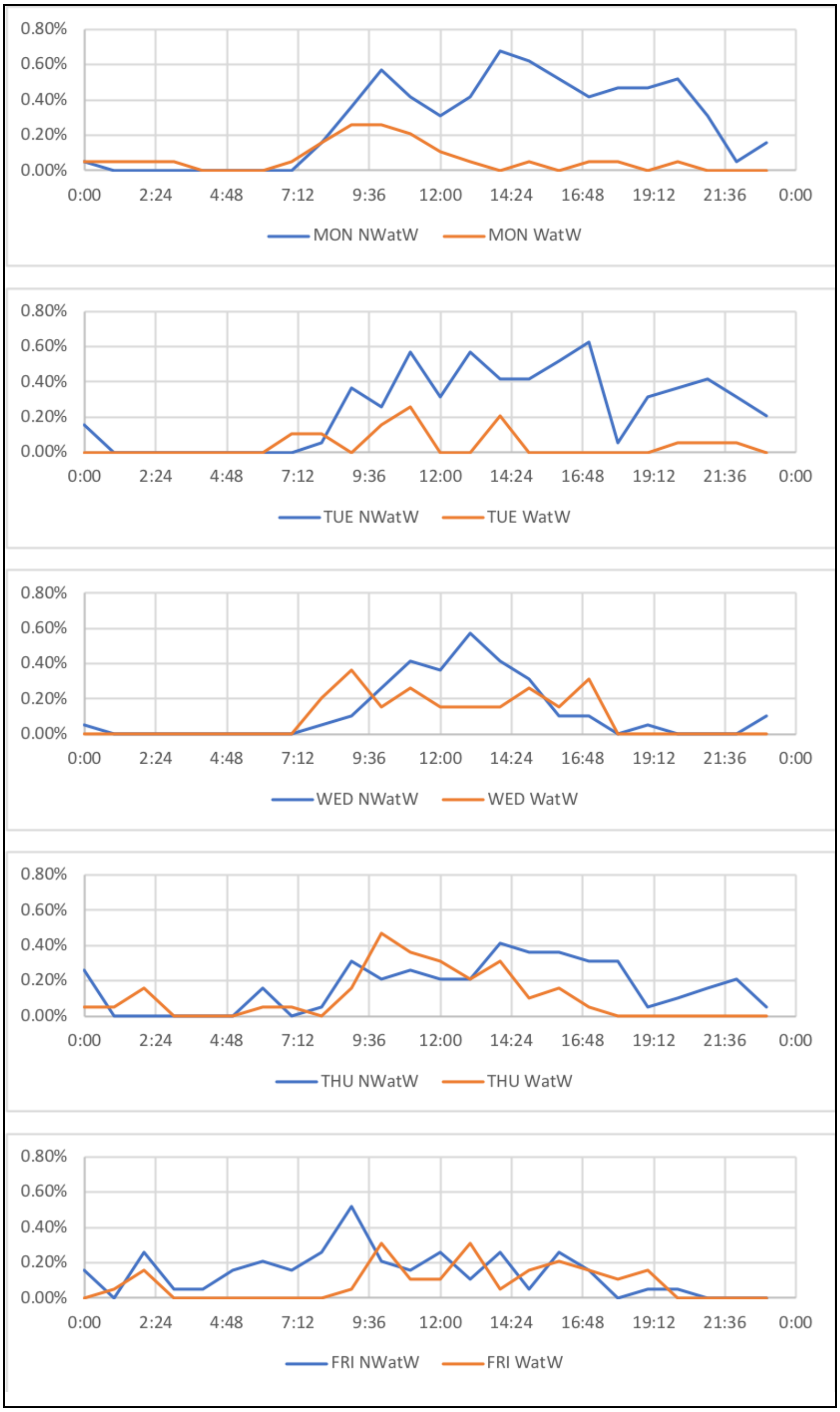


Figure 12 Visualization of session occurrence probability by time frame (NWatW, WatW)

To obtain more detailed information on work-related smartphone usage, the distribution of daily occurrence probability in NWatW and WatW sessions during weekdays for mainly performing work was investigated. Figure 12 shows that there are occurrence probabilities of WatW and NWatW sessions on all days. During work hours, no specific day/time is observed for either work-related or non-work-related smartphone usages. The results imply that smartphones are not used only for one purpose during work hours.

Even though the probability of non-work-related smartphone usages is higher, higher sections of both probabilities alternate with each other on Wed/Thu/Fri. Similar to the weekly distribution, the results show that daily usages related to work increased on Wed/Thu/Fri. In general, smartphones were used for work more frequently in the morning than in the afternoon. In particular, they were frequently used for non-work purposes during the morning on Wed/Thu/Fri compared to work purposes. In addition, usage for non-work purposes in the afternoon showed higher frequency than in the morning, except for Friday.

3.3.3 App usage analysis and clustering

The types of applications recorded in the log were investigated to examine the contextual aspects of smartphone usage in each session group. As stated in the method section, the applications were classified into 11 types. Among 45,398 events, 45,172 events were included for application analysis, excluding the logs recorded as “forgotten.” The following indicates the usage distribution of applications in each session group obtained from the analysis (Figure 13). The highest proportion of usage is mostly MIM (30.69%) throughout the overall sessions. In contrast, the lowest proportion is education/information applications (1.58%).

In each session, MIM was the most popular application in WatNW and WatW. However, the application related to productivity was the second most popular. Conversely, SNS showed second highest usage in NWatNW and NWatW. MIM showed relatively high proportion of usage for non-work purposes, with a distribution of NWatW (23%), WatW (8%), WatNW (4%), and NWatNW (65%). In SNS, it was observed that most of the usage was for non-work purposes with NWatW (27%), WatW (2%), WatNW (0%), and NWatNW (71%).

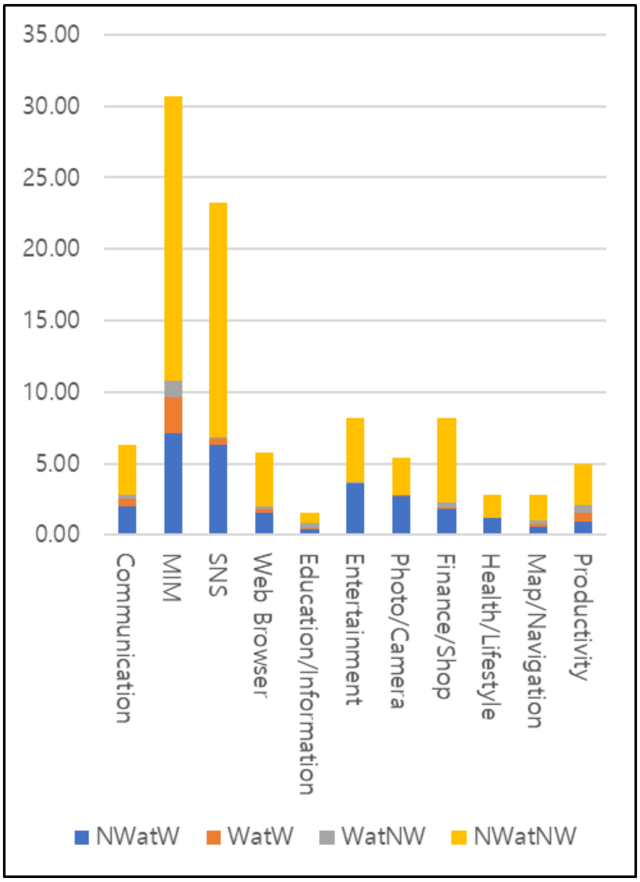


Figure 13 Distribution of application usage type per session

Applications containing high occurrence probability in the sessions were clustered and analyzed to observe the relationship between their group types. All probabilities that could be estimated in each category were calculated. Depending on the values, if it was not possible to estimate the difference owing to them having the same number, LSS, which is the probability of a sequence, was extracted for further analysis. In each session, a transition matrix was extracted to obtain LSS. Visual Basic included in Microsoft Excel was applied for the analysis. For example, if the types of applications were processed as 1 > 2 > 2 > 1 > 1, the values were calculated as follows:

$$LSS = \frac{\ln(\Pr(1) * \Pr(1 \to 2) * \Pr(2 \to 2) * \Pr(2 \to 1) * \Pr(1 \to 1))}{N}$$

$$= \frac{\ln(0.154592 * 0.009695 * 0.275223 * 0.008964 * 0.043163)}{5}$$

$$= -3.13013$$

Application categories were clustered by estimating the LSS value and occurrence probability in each session. In the analysis, SPSS (ver. 23, IBM) was applied using the clustering method. The groups of the application category were extracted as follows: 1: Communication, SNS; 2: Web Browser, Productivity; 3: SNS, Entertainment, Photo/Camera; and 4: MIM showed relatively high probability. These categorized clusters signify the probability of each application operating in one session simultaneously. In Table 5, for instance, 870 sessions in cluster 1 had a high probability that contained communication (20%) and SNS (22%), but there was a low probability of education/information and productivity applications. The cluster analysis proved the results through one-way ANOVA with 0.000 as the level of significant probability.

	Cluster (P=0.000***)			
	1	2	3	4
LSS	-0.1207	-0.5924	-1.2621	-0.0187
Communication	20%	3%	0%	5%
MIM	9%	3%	0%	80%
SNS	22%	0%	26%	3%
Web Browser	12%	20%	0%	4%
Education/Information	2%	0%	2%	0%
Entertainment	11%	2%	27%	2%
Photo/Camera	4%	0%	21%	1%
Finance/Shop	8%	1%	14%	1%
Health/Lifestyle	4%	1%	8%	1%
Map/Navigation	5%	0%	3%	1%
Productivity	3%	70%	0%	3%
N	870	192	58	805

Table 5 Clustering based on app probability and sequence

Chi-square analysis was performed to investigate the relationship between the four extracted application clusters and types of sessions (Figure 14). Among the four clusters, clusters 1 (Communication and SNS) and 4 (MIM) had the highest proportions in NWatW/NWatNW and WatW/WatNW. Thus, it was observed that communication and SNS were the applications used for non-work purposes, whereas MIM showed the highest usage rate for work purposes.

However, communication and SNS were recorded as the second-highest clusters in work sessions, and MIM was the second highest for non-work sessions. Accordingly, clusters 1 (Communication and SNS) and 4 (MIM) were alternatively shown in the ranks, but they were the most popular clusters with the first and second ranks. Compared to other sessions, cluster 2 (Web, Productivity) was relatively predominant in WatW and WatNW sessions. Further, cluster 3 (SNS, Entertainment, Photo/Camera) was relatively included in the non-work sessions. This was proved through the Chi-square analysis of the session in each cluster and type with only 0.000 as the level of significant error.

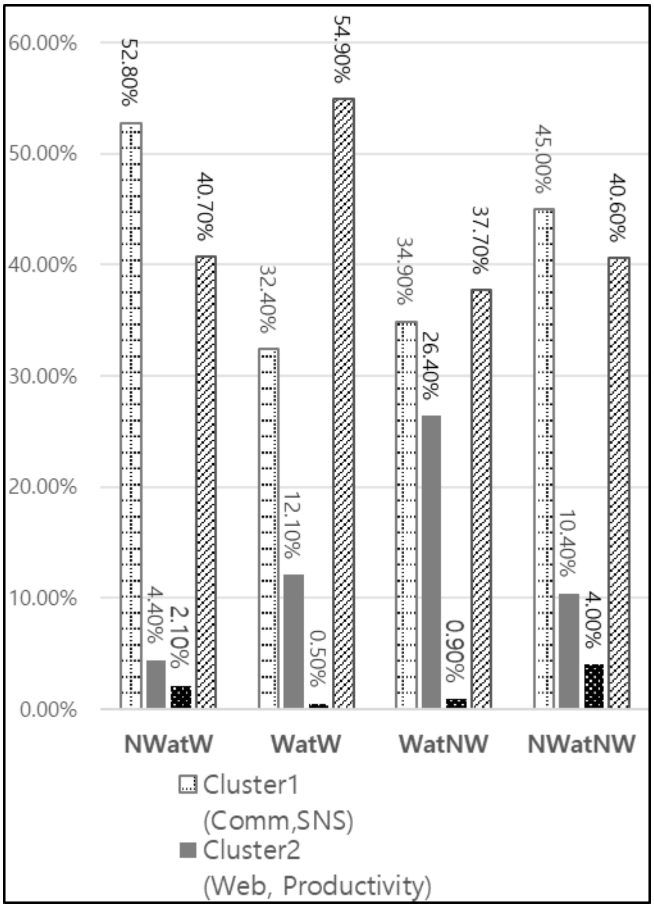


Figure 14 chi-square analysis between work group and app probability clusters

3.3.4 Switching behavior and patterns

The previous analysis described the "trends of smartphone usage for work or non-work purposes." In this part, "the usage of smartphones that could occur between working and non-working behaviors” is discussed. The previous analysis mainly focused on subjects, but switching behavior was based on a streak as an object. As a session was evaluated through a gap of more than 5 minutes with a comparable macro level of the unit, it did not imply any mixing or congestion even if working features were changed between sessions. Accordingly, the switching behavior between event chains was observed for a more detailed and concrete investigation.

Switching patterns in a streak

I tried to determine the patterns of users switching their working and non-working behaviors in one streak depending on the condition of the work situation. For this purpose, the event chain was regulated by connecting the same types of events in each streak and then switching the order. The number of switches and the time of the event chain were analyzed. Among 3,189 streaks, only 365 were analyzed because 2,824 heterogeneous switches between event chains could not be analyzed as switching behavior.

Considering the total number of streaks, heterogeneous event chains were the highest (38%, N = 62) in the WatNW streak, followed by WatW (25%, N = 70/280), NWatW (10%, N = 84/848), and NWatNW (8%, N = 149/1,895). Heterogeneous event chains occurred more frequently in the streak for work purposes. As shown in Figure 15, the event-chain switching within each streak typically occurs less than three times (85.48%, N = 312). Exceptionally, 12, 16, and 22 event-chain transitions were observed within the streaks contained in NWatNW.

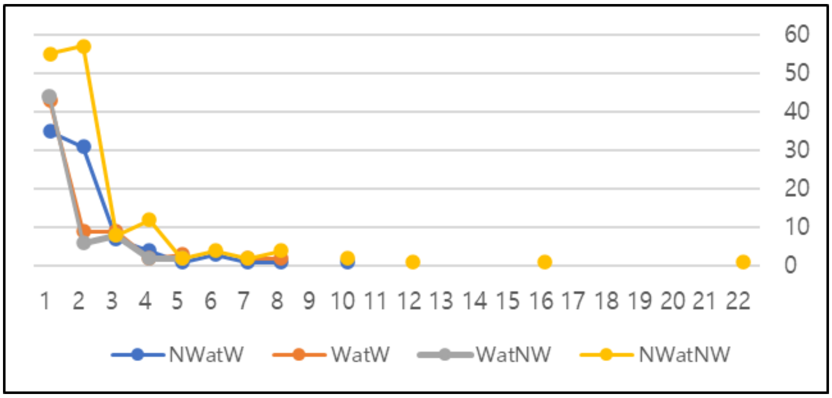


Figure 15 Number of Event-chain switching in Streak for each work characteristic

The patterns of potential usages were extracted based on the method for analyzing data. The heterogeneous switch patterns between the event chains in each streak were classified into the following seven types, according to their popularity (Figure 16). In addition, I measured the total length of the streaks contained in each pattern in seconds. The total time length of 365 streaks with heterogeneous transitions was 112,300 seconds, accounting for 15.84% of the total length of 3,189 streaks, 708,955 seconds. Each pattern was categorized without overlapping.

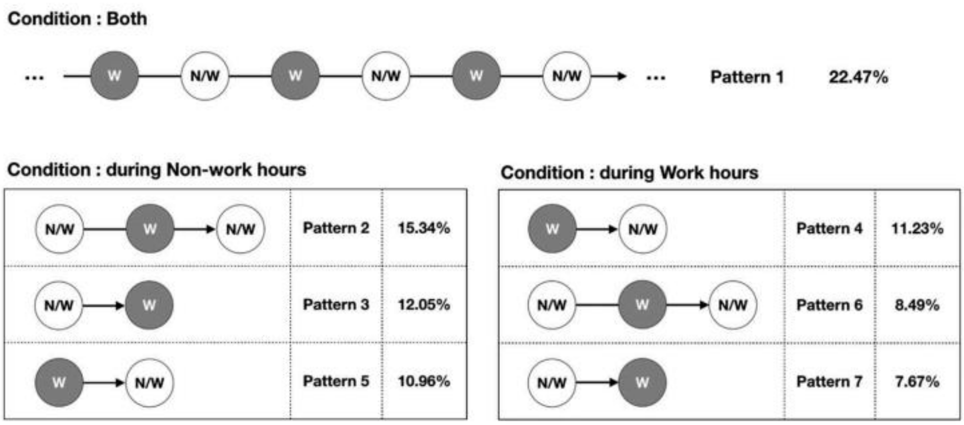


Figure 16 Visualization of Event-chain switching patterns

1) Wandering between work and non-work (22.47 %, N = 82, 38,974 seconds)

Occupying the highest portion of patterns among heterogeneous switches, working and non-working behaviors were observed alternatively more than three times during work and non-work hours. Thus, this pattern implied that the users did not focus on only one behavior when they used smartphones. In this pattern, from a total 82 streaks, 42.68% were observed in work situations and 57.31% were observed in the non-working state, which occurred more frequently in non-working situations. In the pattern, the maximum value was 22 times in the event-chain switch. Based on the time of use, this pattern was the longest, with 35% of the total pattern (38,974 seconds in 112,300 seconds). In other words, people spent relatively more time wandering between work and non-work on a smartphone compared to other patterns. The pattern of this characteristic has the longest average time per streak of 475.29 seconds. Once users start roaming on their smartphones, it can be inferred that they do not concentrate for an average of eight minutes.

2) Interrupted by work (15.34%, N = 56, 18,060 seconds)

This is a streak pattern that consists of three event chains and two switches between them. This pattern implies that a user uses the smartphone for non-work purposes at a time other than work, interrupts smartphone use owing to work-related use in the middle, and then returns to the original non-work purpose. This pattern shows how much work interferes with leisure behavior in non-work time. It is the second most frequent pattern when viewed in terms of frequency and time.

3) Transition to work (12.05%, N = 44, 7,457 seconds)

This is a pattern with one event-chain transition that users utilized smartphones for non-working purposes during their non-work hours. It indicates that users started to use smartphones for their leisure, switched to working purposes, and then stopped.

Between two event chains in the streak during non-working hours, of the total 44 switches in this pattern, it was 52.27% where users spent more time for work purposes and the opposite was 47.73%.

4) Transition to cyberslacking (11.23 %, N = 41, 5,418 seconds)

These patterns include one transition of event chains from work to non-work purposes. Within this pattern of two event-chains, 60.98 % of the total 41 switches were longer for work purposes than for non-work purposes. Thus, this implies that there is a relatively high proportion of the cases that users instantly performed cyberslacking after work-purpose use during office hours.

5) Returning to leisure (10.96%, N = 40, 6,533 seconds)

This pattern indicates one transition of event chains from work purposes during non-working hours to non-work purposes. In this case, users worked during non-work hours and then switched to a non-working pattern. In the proportion of event chains, of the total 40 switches, they spent more time for non-working purpose with 70.00 % after work purpose uses.

6) Work between cyberslacking (8.49%, N = 31, 7,722 seconds)

This pattern shows two transitions between three event chains where users used smartphones for non-working purposes during work hours, switched to the working mode, and then reverted to non-working purposes. This implies that first, users used smartphones for work and performed cyberslacking and then went back to work. In this pattern, the case where users spent time for working than for non-working purposes was only 19.35% of the total 31 switches; thus, they used smartphones mostly for cyberslacking.

7) Returning to work (7.67%, N = 28, 4,609 seconds)

This pattern is the transition of event chains from non-work purposes to work purposes during office hours. Initially, users used smartphones for leisure and then for work. Identical to the previous pattern, it was shown that the usage for non-work purposes occupied a higher proportion.

8) Other (11.78%, N = 43, 23,527 seconds)

More complicated groups that were excluded in the previous seven types constituted 11.73% of the total 365 switches. These showed various features. For example, users used smartphones for work, followed by cyberslacking, and then recovered to the working mode; before starting work, they used it for recreation and kept using it even after work hours.

3.4. Limitation and Future Work

This study investigated log data that were automatically recorded in smartphones to obtain practical results. However, only the starting times of applications were collected and not the closing times, which produced a limitation in analysis. Therefore, break time was estimated by referring to the average usage time from previous studies. Based on the average end time, I attempted to minimize errors by comparing two analysis methods. However, these approaches depend on estimation or assumption; thus, gaps from actual behavior could exist. Consequently, a device that can accurately record the end times of applications is required for future research.

This study analyzed the log data collected from 18 subjects for 72 hours. A total of 45,398 events were collected; however, they were limited to generalize the phenomenon. In addition, as the working environment could change quarterly, it is necessary to collect long-term data. Because smartphone usage could be related to working in a specific position in a few cases, more diverse subjects are required to produce reasonable conclusions. All of the subjects of the study were office workers, but in terms of the composition of the subjects, the behavior of using smartphones may be related to the company's work content, raising the need to recruit users from more diverse industries. Therefore, in order to cope with these limitations, it is necessary to organize a group of subjects by industry in future studies to collect more long-term data.

Instead of collecting data over the long term from numerous people, I attempted to apply the context of data by recording data including work characteristics from small sample groups. Using the diary method, users directly tagged the collected log according to their behavior or pattern. Furthermore, I asked them to perform tagging every 24 hours to minimize data loss due to oblivion. The method reduced the loss of data compared to an interview or survey consisting of comprehensive questions. However, errors still existed in the diary method because the users directly recorded the event log, and users' subjectivity was included in the log. Thus, a new system that records logs automatically and reduces the gap between recordings to below 24 hours must be developed. However, recording must not affect work; hence, an optimum gap should be introduced.

As I obtained results using the log data collected from users, there is a limitation in qualitative analysis. In relation to the usage patterns obtained through quantitative analysis, it is necessary to study qualitatively why users play with smartphones during office hours, why their transition happens in office hours, and how this can be improved. Therefore, future work requires the addition of interviews or participatory research.

3.5. Conclusion

In this study, the usage log of smartphones was categorized into four types of sessions depending on the work environment and purpose of use, and these were compared with each other. From the results, I analyzed how behaviors are mixed between slacking and work and how frequently smartphone usage occurs during working and leisure hours. Moreover, group analysis showed which applications have been used in relation to the work environment. When users used smartphones sequentially, the trends in the degree of mixing between work and leisure were extracted by analyzing their usage patterns.

To investigate the usage of smartphones for work on a practical and detailed level, sessions and streaks were analyzed by automatically collecting logs. It is meaningful to extract smartphone usage on a practical level that could be detected in previous approaches, such as interviews and surveys. Research shows that people use smartphones frequently in both work and non-work-related scenarios. As a result of the session analysis, the smartphone was not dedicated to either work or non-work. In addition, app analysis results show that apps such as Communication, SNS, and MIM are included at a high rate both for work purpose and non-work purpose use. Therefore, the concentrated use between work and non-work at the app level was hard to find. Based on these results, work and non-work behaviors in smartphones are often mixed in a chemically fused manner, beyond simply being able to distinguish by time zone or app. This was also true for the streak analysis. Among the usage patterns classified by us, “Wandering between work and non-work” pattern, in which work and non-work are alternately converted more than three times, occupied the highest proportion in both time and frequency of occurrence. Based on these results, I conclude that the current smartphone approach for self-regulation or blocking the app is not effective. I suggested a selective blocking strategy within each app to help users block detailed action units. I think that this approach can help solve problems such as cyberslacking or failing to leave the workplace on time.

As described above, this study has a limitation in producing qualitative analysis and design implications and providing only generalization problems owing to the small number of subjects and the distortion of data that could be introduced into the recording diary by users. Therefore, I will propose more concrete alternatives in future research to overcome the current limitations.

4. In-App Switching Behavior:

A Study of Work and Non-work chat room switching and User's strategies in Mobile Instant Messenger apps.

This chapter presents the search results for RQ3 (How do the switching patterns and distributions between work and non-work conversations appear in MIM?) and RQ4 (How do MIM users manage switching between work and personal conversations?). As the study presented in Chapter 3 shows, the use of MIM apps was the highest among all smartphone apps, and the mixture of work and personal use in MIM apps was the highest. In addition, the results of the probability analysis according to the work situation showed that people engaged in MIM app sessions for work and non-work purposes in the workplace [198]. These results were the core background of and motivation for conducting the research I present in Chapter 4. Based on these results, I explored switching between work conversations and personal conversations in MIM apps. To this end, I collected the actual work conversation and personal conversation records in a MIM app (KakaoTalk) for 30 days and 92 days, respectively, and discovered the correlation between switching patterns and conversation characteristics (conversation participation rate, conversation frequency, etc.). In addition, through interviews, I investigated users' perceptions and response strategies for personal conversations during work or after work conversations from a qualitative perspective. I have reported and published some of the research content and results of this chapter at *iConference 2020* [211]and in the *Journal of the HCI Society of Korea*. [212]

4.1. Motivations

As people actively use smartphones for work purposes [2], [22], personal and work use are mixed in a single medium. In particular, people frequently use MIM apps for work conversations and personal conversations [56], [155] because of their ease of use and access, their file transfer feature, their lack of additional costs, and the ability to use group chats [55]. For this reason, work and personal conversations take place simultaneously in MIM apps. Therefore, at work sites, problems arise from employees having personal conversations with MIM apps during work hours. At the same time, at home, the problems arise of increased stress and workload when people engage in work communication after work [39], [154]. As a result, the use of MIM apps is blurring the boundary between work and personal domains [72], [198], and users are exposed to pervasive multitasking and task switching between heterogeneous conversations, experience cognitive burdens, and find distinguishing work from leisure difficult [2], [22], [23], [203].

To solve these problems, technical, social, and academic approaches has been studied. First, technically, service providers such as Apple and Google provide blocking functions, which prevent notifications from a specified app at a specified time and restrict use [161], [164]. They also allow users to manage themselves by showing how much each user has used each app for a day or a week. Regarding the social approach, people have argued for the need for user self-regulation to prevent cyberslacking behaviors [80], in which people use smartphones for non-business purposes at work [204], [213], [214]. On the other hand, after work, discussions and legislation have arisen to prevent post-work contact as a social issue [215], [216]. On the academic side, researchers have conducted studies to find the optimal notification time by reducing unnecessary notifications or delaying the time to solve interruption problems notifications cause [84], [158], [176], [217].

However, these approaches are mainly based on blocking the app or notifications coming from the app; therefore, the problem of mixing personal and work use in a single app, such as MIM app, can only have partial solutions. In addition, one study showed that even a short refresh time when one uses MIM apps, even during work hours, contributes to increased productivity [53], [54]. This finding suggests that HCI strategy is needed beyond the blocking approach.

To create effective management methods, empirical analysis of how work and personal conversations are mixed in MIM apps during work and leisure time is required. However, in previous studies, researchers have mainly analyzed app-level usage behaviors rather than micro interactions in one app, but such studies have limitations in capturing actual usage behaviors by collecting data through surveys [9], [18], [71], [207]. Considering this background, I collected an automatically recorded MIM app conversation log from the field and performed an empirical analysis. I also analyzed the switching pattern to observe the mixing of work and personal conversations over time. In addition, I conducted user interviews to investigate how users manage conversations in this mixed situation, revealing motives and alternative usage strategies that are difficult to observe in a quantitative analysis. I conducted this study in accordance with the following research questions:

RQ3. How do the switching patterns and distributions between work and non-work conversations appear in MIM?

- What is the pattern of switching between work conversations and non-work conversations within MIM?

- How does each type of switching, such as heterogeneous switching (work-non-business) and homogeneous switching (work-business, non-business-non-work), correlate with conversation characteristics (conversation participation rate, conversation frequency, conversation initiation)?

RQ4. How do MIM users manage switching between work and personal conversations?

- What are the types and effects of detour strategies that users autonomously attempt to resolve due to inconvenience caused by distraction in using MIM?

4.2. Study Design

4.2.1 Data Collection

I collected MIM app chat logs from smartphone users. I chose Kakao Talk, the most used MIM app in Korea. Participants in the study were knowledge workers who currently perform certain tasks at fixed working hours every day in workplaces and graduate schools, and I recruited people who are currently using KakaoTalk at work. I set the research subject this way because it maintains consistency with the previous research and is suitable for the research problem to be identified in this study. Office workers who work with PCs and mobile devices can use their smartphones to receive work calls anytime and anywhere and handle simple tasks as long as they are connected to the Internet. I conducted a study on them because they frequently experience a mixture of work and personal life with their smartphones. I recruited participants by snowball sampling through a KakaoTalk group chat. I ultimately enrolled 10 participants. Of the participants, 8 were in their 20s and 2 were in their 30s. To collect work and personal conversations separately, I collected the chat logs by instructing the user to select three of the most frequently used work and personal chat rooms. To filter out inactive chat rooms, I conducted a preliminary interview to determine the number of chat rooms that participants attended at least five days a week. In addition, the results of external institutions [218] regarding the average number of group chat rooms (average 5.9, N=731) and the results of the Korea Press Foundation Media Research Center (average 5.7, N=1,019) were reflected [219]. Based on these factors, I set the number of chat rooms to use for my research.

I collected data online, informed the participants of the anonymity and post-investigational disposition of all data, and received their informed consent. To avoid providing unnecessary personal information, the users extracted the log directly from the smartphone and then processed the conversation data file using Microsoft's Excel VBA macro, created and distributed by the researcher, and sent it to the researcher. This macro is designed to load the KakaoTalk conversation text file and automatically delete its contents, leaving only the send and receive information and time of the message, as Figure 17 shows. I collected data in two phases (30 days in the 1st, 92 days in the 2nd).

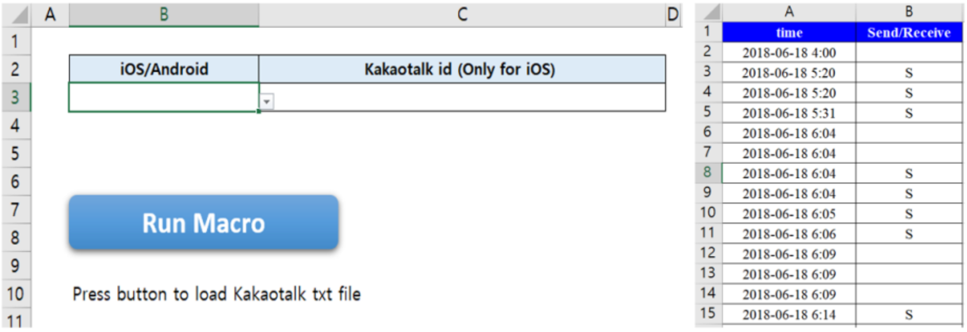


Figure 17 Data collection-tool screen (left) and examples of results using VBA macros (right)

4.2.2 Data Processing

I collected data from 60 chat rooms (30 work, 30 personal), 6 for each study participant. This study comprised analysis in two phases: I analyzed the 30 days of chats recorded in September 2018 in Phase 1 and the 3 months of chats recorded in the first half of 2018 in Phase 2 to increase the amount of data. I combined the data for each participant, as Figure 18 shows. In addition, I divided the data into sections with and without continuous talk log data in chronological order based on the work by Böhmer et al. [193] and [209]. This is the same as the classification method presented in Chapter 3 for smartphone log data.

"Session" means the time in which conversations took place. Sessions are delimited by a long break, which is a period of more than 5 minutes in which no incoming or outgoing communication occurred in any chat room. I referred to Jones et al. [194], who found that the average time between instances of smartphone use is about 5 minutes. In addition, based on my finding that the average time of app use is 72 seconds [193], I defined a period in which message exchange did not occur for more than 2 minutes and less than 5 minutes as a short break. In Chapter 3, I grouped and classified use logs for the same purpose as event chains, but in the MIM app target study presented in Chapter 4, I modified the name to "talk chain" for more intuitive understanding because all logs comprised talk. In addition, I grouped series of work chats and personal chats into talk chains in a session. "Talk" means one record of a MIM app conversation regardless of whether it was incoming or outgoing.

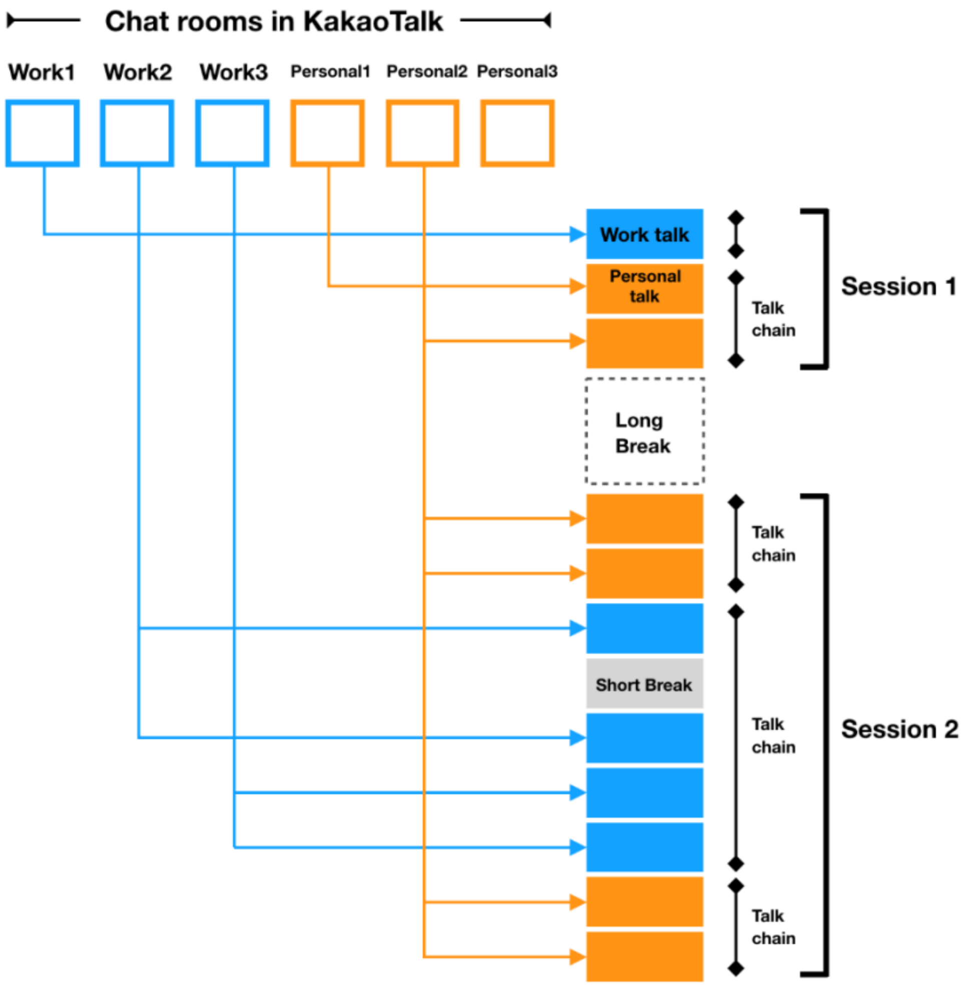


Figure 18 Visualization of classification method for sessions and talk chains

	Description
Session	Independent conversation periods separated by long breaks.
Talk	One Kakaotalk Message in the log data
Talk-chain	Period of continuous conversation with the same characteristics. (work or personal)
Long break	Periods with no interaction for more than 5 minutes
Short break	Period of interaction that did not occur for more than 2 minutes but less than 5 minutes

Table 6 Description of terms and measures

4.2.3 Data Analysis and Interview

Regarding the research problem, I analyzed (1) the distribution of MIM app use in work and leisure time, (2) the switching pattern between work chat and personal chats in a session, (3) the correlation between conversation concentration and conversation features, and (4) the user's MIM app usage strategy in mixed situations. Regarding (2), I analyzed switches between talk chains included in each session as I did in the study presented in Chapter 3. However, unlike in that study, I conducted this study on a single app (MIM), so I examined switching between talk chains in a session without separately classifying streaks.

First, I recorded the proportions of personal and work chats in the collected sessions. I then analyzed the distribution according to the time the chat session took place (while at work or after work). I also divided the sessions into four groups for analysis: personal chat at work, work chat at work, work chat at non-work, personal chat at non-work.

Second, I identified cases in which work chats and personal chats were mixed in a session and analyzed the switching patterns in these sessions. I based the pattern classification on (1) the time that the chat took place (at work or after work), (2) the frequency and sequence of switching between work and personal chats in the session, and (3) the proportion of work and personal chats. Of all the types classified based on these criteria, I classified the types with long duration and high frequency according to the ranking as the main pattern.

Third, I analyzed the correlation between the conversation concentration and each conversation's characteristics. I classified conversation concentration as follows according to how the user switched between six chat rooms (three individuals and three tasks) in a session. First, "no switching" is the type in which the conversation is most concentrated, and it means that one session is held only in one chat room without switching. "Heterogeneous switching" means that switching occurs between personal and work chat rooms in a session. In other words, personal and work conversations are mixed in one session, and it can be seen as the type with the lowest concentration. Finally, "homogeneous switching" refers to a session in which the user switches between chat rooms of the same type (i.e., switching from a work chat room to another work chat room or from a personal chat room to another personal chat room). The degree of concentration is lower than that in the "no switching" type due to the switching between chat rooms, but the activity is less mixed than in heterogeneous switching. I examined how these three types correlate with the conversation characteristics of conversation participation, conversation exchange frequency, and conversation initiation. I determined conversation participation based on how many messages the user sent among the entire session's log, the number of transmissions and replies, and whether the participant's outgoing messages initiated each session.

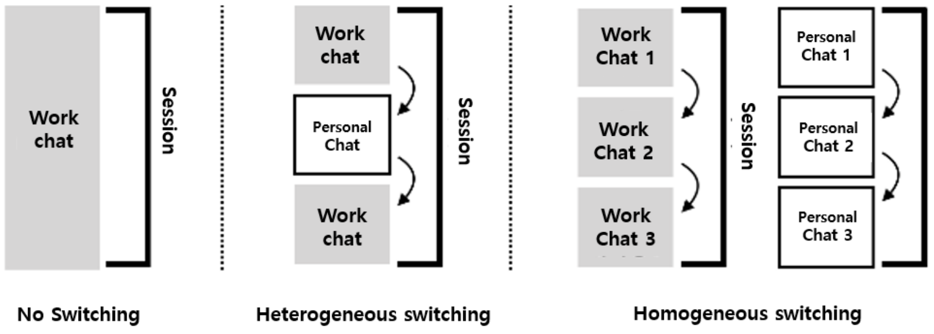


Figure 19 Classifying types of switching between conversations

Finally, I conducted data elicitation interviews. I visualized the most recent weekly use history of the collected log data in a graph, such as the one in Figure 20. I showed it to the study participants and asked questions regarding how they manage the mixed situation of work chats and personal chats, the effectiveness of existing methods to block the use of MIM apps, their personal conversations at work, and their method of handling work conversations during leisure time. I conducted a 30-minute face-to-face interview with each participant. After the interviews, based on the questions, three experts in the HCI field classified the responses. After discussion, we reviewed each other's classifications and determined the final classification.

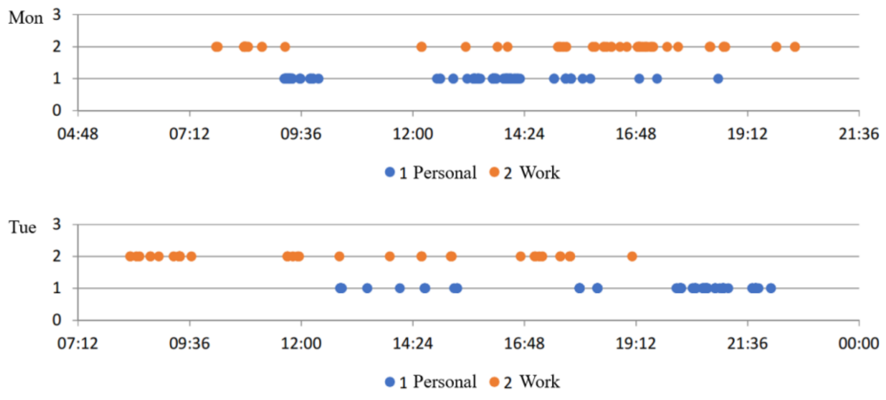


Figure 20 Data visualization example for data elicitation interview

4.3. Results

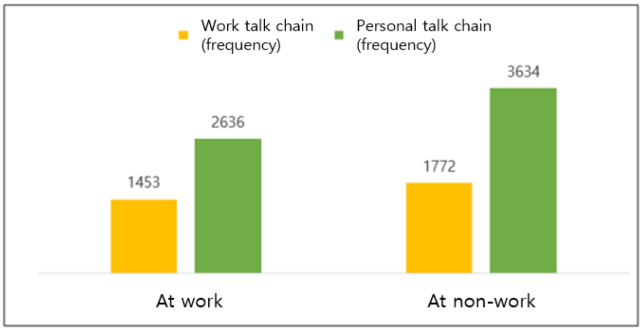
4.3.1 Phase 1 (30 days)

1) Quantitative Observations

I collected data from 10 participants for 30 days in Phase 1, collecting 103,344 logs. I classified this log data into 7,276 sessions separated by long breaks. Table 7 shows the detailed characteristics of the session.

	Average	Standard Deviation	Total (N=7276)
Length of session	287 seconds	500 seconds	34,847 minutes
Number of Talks	14.2	47.89	103,344
Number of short breaks	1.58	1.16	11,503
Number of outgoing messages	3.42	10.9	24,877
Personal talks	9.93	37.82	72266
Work talks	4.27	28.0	31078

Table 7 Phase 1 session details



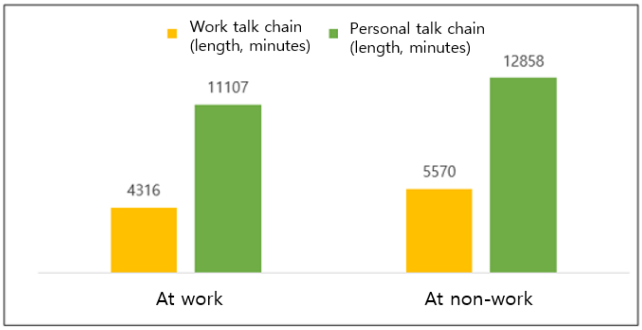


Figure 21 The distribution of talk chains in terms of frequency and session length (minutes)

To analyze the distribution of personal and work use during work and leisure time, respectively, I examined the distribution of talk chains in each session. In the distribution, the length and frequency criteria showed that the number of personal talk chains higher in non-work time than in work time. In terms of frequency, the particpants recorded 1453 (35.5%) work talk chains and 2636 (64.5%) personal talk chains during work. During non-work hours, they recorded 1772 (32.8%) work talk chains and 3634 (67.2%) personal talk chains. This trend was similar when classified based on the total length of use (hours). From this, about 2/3 of KakaoTalk use during work was for personal conversation, and about 1/3 of KakaoTalk use during non-work time was conversation for work purposes. In other words, a considerable part of conversations for work and personal purposes are mixed in the use of KakaoTalk.

2) Conversational Characteristics and Correlation Analysis

I examined the correlations, such as conversation participation, conversation exchange frequency, and conversation initiation, between the three switching types (Fig. 19) (Table 10).

First, the no switching type showed a negative correlation in session length, number of short breaks, participation, chat initiation, and chat exchange frequency. Therefore, in a situation in which one concentrates on one conversation without switching chat rooms, the conversation participation and exchange frequency are low, the conversation is short, and the conversation continues without a break in the middle. (Figure 22)

The heterogeneous switching type showed positive correlations in conversation length and exchange frequency. In a situation in which work and personal conversations are mixed, the conversation is long and the number of messages is large. Although there is a limitation in that it was not significant, heterogeneous-

		number of talks	number of breaks.	duration	participation	chat Initiation	exchange frequency	no switching	homogeneous switching (between work)	homogeneous switching (between Personal)	heterogeneous switching
number of talks	Pearson	1	0.001	0.016	0.003	-0.004	0.001	-0.008	-0.006	0.014	0.013
	Sig. (2-tailed)		0.950	0.181	0.797	0.749	0.966	0.471	0.634	0.250	0.261
number of breaks	Pearson		1	.825***	-0.017	-0.006	.396***	-.417***	.132***	.372***	.322***
	Sig. (2-tailed)			0.000	0.148	0.633	0.000	0.000	0.000	0.000	0.000
duration	Pearson			1	-.029**	-0.015	.633***	-.410***	.168***	.466***	.483***
	Sig. (2-tailed)				0.013	0.205	0.000	0.000	0.000	0.000	0.000
participation	Pearson				1	.767***	.077***	-.047***	0.004	.037***	-0.005
	Sig. (2-tailed)					0.000	0.000	0.000	0.730	0.002	0.649
chat Initiation	Pearson					1	.063***	-.049***	-0.007	.039***	-0.001
	Sig. (2-tailed)						0.000	0.000	0.554	0.001	0.927
exchange frequency	Pearson						1	-.250***	.118***	.449***	.432***
	Sig. (2-tailed)							0.000	0.000	0.000	0.000
no switching	Pearson							1	-.221***	-.388***	-.371***
	Sig. (2-tailed)								0.000	0.000	0.000
homogeneous switching (between work)	Pearson								1	-0.006	.145***
	Sig. (2-tailed)									0.600	0.000
homogeneous switching (between Personal)	Pearson									1	.122***
	Sig. (2-tailed)										0.000
heterogeneous switching	Pearson										1
	Sig. (2-tailed)										

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

Figure 22 Correlation between session and conversation features by task characteristics

switching shows a negative correlation in participation and initiation, so the mixed-conversation situation entails low participation and a small number of outgoing messages.

I analyzed homogeneous switching by dividing it into two types according to the nature of the conversation (switching between work chat rooms and between personal chat rooms). I found a positive correlation between them in the length of conversation and the number of short breaks. The more homogeneous switching occurs, the longer the conversation and the more intermittent disconnections from the conversation occur.

Compared to switching between business chat rooms, switching between personal chat rooms showed a significant positive correlation in the degree of conversation participation and initiation (or non-initiation). Therefore, the user mainly initiates the situation in which they switch between several individual chat rooms, and the level of participation in the conversation is high.

3) Heterogeneous Switching

I determined how much heterogeneous switching occurs in the three switching types. This analysis included only sessions in which heterogeneous switching between the work talk chain and the personal talk chain occurred at least once in one session, and I included 572 sessions in the analysis (7.86% of 7276 total). Based on the session's length, it was 24.7% of the total (8594 of 34,847 minutes).

I classified 572 sessions based on (1) whether they took place during office hours, (2) the number and order of switches between work and personal conversations in a session, and (3) the proportions of work and personal conversations in a session. I determined the number of switches by setting the classification criteria as "once," "twice," and "more than three times," considering that the talk chain was switched less than two times in 61.19% (N=350) of the sessions (Table 8).

Talk chain switching	**switching order**	**Percentage in a session**	**Number and time of sessions depending on the situation**		**Number and time of sessions**	**Average Session Length**
			At work	At non-work		
Once	A: work → Personal	work<personal	15(137)	19(147)	102 (744)	(7.29)
		work>personal	15(167)	15(166)		
		work=personal	14(52)	24(75)		
	B: personal → Work	work<personal	21(181)	13(108)	113 (666)	(5.89)
		work>personal	18(128)	14(107)		
		work=personal	23(73)	24(69)		
Twice	C: work → Personal → Work	work<personal	2(56)	2(17)	54 (648)	(12)
		work>personal	24(224)	26(351)		
		work=personal	0(0)	0(0)		
	D: personal → work → personal	work<personal	51(578)	27(368)	81 (987)	(12.19)
		work>personal	0(0)	1(26)		
		work=personal	1(7)	1(8)		
More than 3 times	E: repeated switching	work<personal	47(1453)	53(1640)	222 (5549)	(25)
		work>personal	41(805)	57(1454)		
		work=personal	9(79)	15(118)		
Total					572 (8594)	(15.02)

Table 8 Talk-chain-switching analysis results and distribution (length in parentheses, in minutes)

In Table 8, the classification according to the number of switches is shown on the left. I classified sessions into five types based on the switching order in the session: A (1 switch occurred in the session, from work talk to personal talk), B (1 switch occurred in the session, from personal talk to work talk), C (2 switches occurred in the session, from work talk to personal talk and back to work talk), D (2 switches occurred in the session, from personal talk to work talk and back to personal talk), and E (3 or more switches between work talk and personal talk).

I then classified the sessions based on the proportion of conversation time in the sessions and whether the work conversations or personal conversations were longer or of the same duration. The table 8 presents the distribution of the total 572 sessions in this way. I classified 572 heterogeneous switching sessions, as Table 11 shows, into 6 main types by considering whether the sessions occurred during work as well as the average and median values of conversation length and session frequency (Figure 23).

The six types derived in this way account for about 79.2% of the 572 cases based on frequency and about 93% of the 8594 cases based on conversation length; therefore, most of the switching types to be analyzed are included in this classification. I classified sessions not included in the six main types as “other.” The 572 sessions included in this classification were independently included for each switching type without overlap.

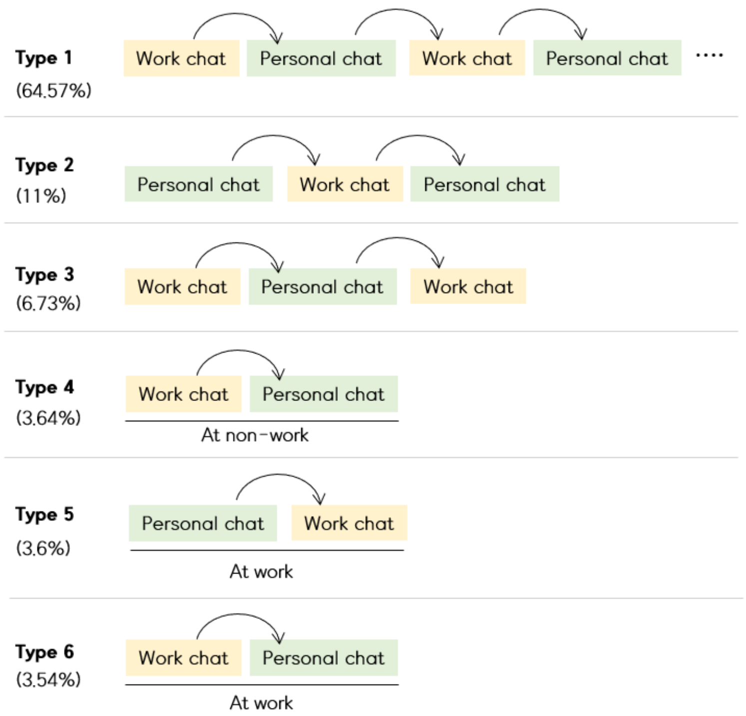


Figure 23 Heterogeneous switching between work and personal conversations

I added frequency and length to session classification and type description. Frequency indicates how often a session of a certain type occurred. In other words, it indicates how often disturbances due to heterogeneous switching occurred during work or leisure regardless of the conversation length. For example, even if a user switched from a work conversation to a personal conversation at work for a relatively short period of 5 minutes, if it occurred 5 times at 10-minute intervals of 1 minute each, this could be considered relatively frequent interruption of work.

Type 1) Mixed work and leisure (N=222, 38.81%; time=5549 minutes; 64.57%): This type included sessions in which the user switched between work and personal conversations more than three times in one session during work or non-work situations. This type, which accounts for the largest proportion of the six types of sessions and length, means that users cannot focus on work or personal conversations and alternately participate in both conversations once they turn on KakaoTalk.

Type 2) Return to personal conversation (N=78, 13.64%; time=946 minutes, 11%): This type included sessions in which the user started with personal conversation and switched back to personal conversation after a short work conversation. 24 sessions (224 minutes) of this type occurred during work, and 26 sessions (351 minutes) occurred during leisure, with similar frequencies.

Type 3) Return to work conversation (N=50, 8.74%; time=575 minutes, 6.73%): This type included a return to a work conversation after a brief personal conversation. 51 sessions (578 minutes) of this type occurred during work, and 27 (368 minutes) sessions occurred during non-work time.

Type 4) Interference with leisure due to work (N=34, 5.94%; time=313 minutes, 3.64%): This type of session began with a work conversation and ended with a personal conversation during leisure. In other words, the work conversation interrupted the leisure situation, but the user ended the work conversation by switching back to the personal conversation. Between the two types of conversations, the longer work conversation was 53% and the longer personal conversation was 47%.

Type 5) Post-deviation work conversation (N=39, 6.82%; time=309 minutes, 3.6%): This is an instance of cyberslacking in which the user switched to a work conversation after a personal conversation during work. Longer personal conversations (58.58%) occurred more frequently than longer work conversations (41.42%).

Type 6) Deviation after work conversation (N=30, 5.24%; time=304 minutes, 3.54%): In this type, the user shifted to personal conversation while conducting a work conversation during work. Business conversations were longer than personal conversations in 54.93% of the cases.

I classified sessions not included in these six main types as "'other" (N=119, 20.8%; time=598 minutes, 7%).

4.3.2 Phase 2 (92 days)

1) Quantitative Observations

The research collected a total of 198,505 talk logs over 92 days and categorized them into 17248 sessions. Of these, 7,670 sessions took place during the work hour and 9,578 sessions took place during the after work. Business hours were referenced to the regular working hours for each participant collected through user interviews. The ratio of work chat and personal chat in each session according to work situation is shown in Figure 24. First, there were 5289 sessions consisting only of private chats in the work hour, 69% of the total, and 24% of sessions consisting only of work chats. Similarly, after work, only personal chat sessions were 73% and only work chat sessions were 22%.

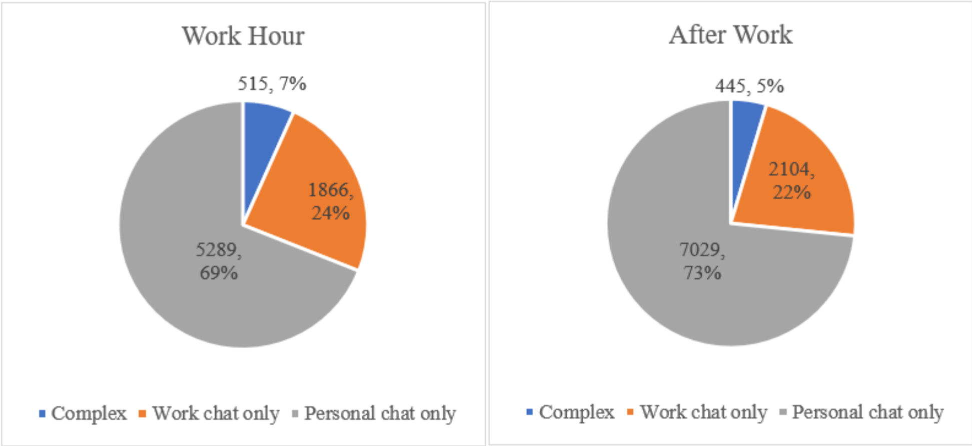


Figure 24 Ratio between personal chat and work chat

Next, I analyzed the distribution of complex sessions in which work chats and personal chats appeared together in one session. In the work hour, there were relatively many sessions with more than 50% of personal chats in one session. (Figure 25, above) On the other hand, after work, there were many cases where work chat and personal chat were mixed in similar ratio. (Figure 25, bottom)

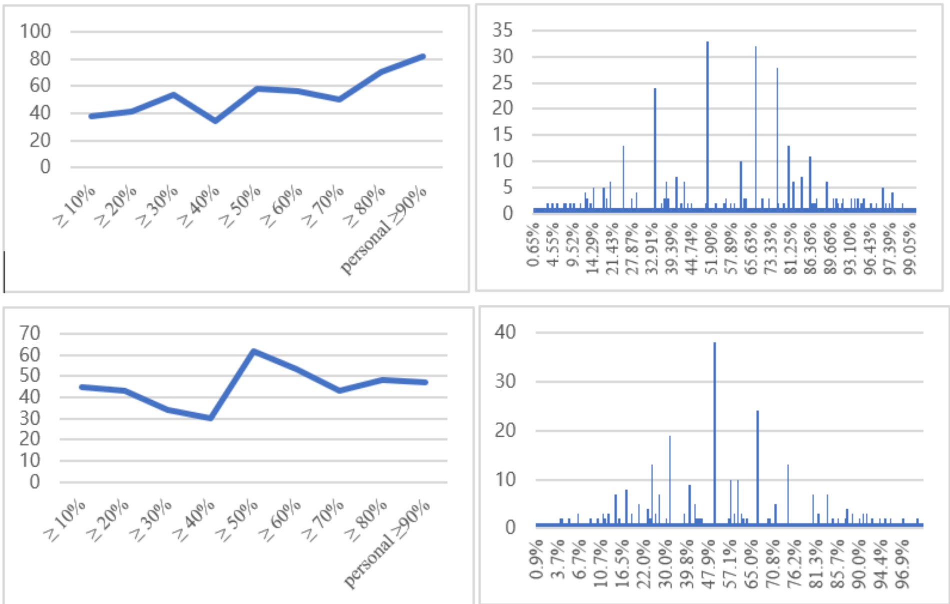


Figure 25 the distribution of complex sessions. (above: work hour, bottom: after work)

Based on this distribution, the sessions were classified into four groups to identify the characteristics of the sessions according to the usage context. (Personal chat at work, Work chat at work, Work chat at Non-work, Personal chat at Non-work) In the case of complex sessions, based on the internal session rate, if the work chat rate is higher, it is classified as a work session, while when the personal chat rate is higher, it is classified as a personal session. To prove significance of group distribution, a one-way analysis of variance (ANOVA) test was performed on each group feature. (Table 2)

The number of sessions was highest in the order of PatNW(7244, 42.2%), PatW(5572, 32.4%), WatNW(2296,13.4%), WatW(2065, 12%). Personal chat had more sessions than work chat. This was shown in the same order in use time. Average talk message within a session was highest in personal conversation (PatW13.09). Compared to work chats, personal chats often start a chat session by sending a message first. (PatW = 39%, PatNW = 35%) On the other hand, work chat at non-work is more likely to be started by others than by themselves. Participation rate, which represents the percentage of messages sent by the user for each session, was also high in the PatW(0.37) and PatNW(0.36) sessions (WatW = 0.22, WatNW = 0.17). As a result, we observed that people participate more actively in personal chat regardless of work situation.

2) Switching Patterns in a Session

In relation to RQ3, I analyzed how switching between work and personal chats took place within a session. This analysis is based on switching between talk-chains. The analysis included only sessions that showed at least one switching between the work talk-chain and the personal talk-chain. The total number of sessions included in the analysis was 960 (5.57%, out of a total of 17248). The length of the session was 14.4% (10,751 minutes out of 74,846 minutes). The number of switching among the classification criteria was set to 1, 2, and 3 or more times considering that 66.3% (N = 636) of the sessions had 2 or less switching. In Table 9, the number in parentheses indicates the time duration, in minutes.

Number of talk-chain switching	Order of switching	Talk time share within a session	Session count and time by work situation		Total	Average usage time within a session
			Work hour (time, minutes)	After work (time, minutes)		
1 time	A: Work → Personal	Work < Personal	30(232)	23(144)	174(1049)	(6.03)
		Work >Personal	33(326)	20(195)		
		Work=Personal	32(80)	36(72)		
1 time	B: Personal -> Work	Work < Personal	37(284)	27(235)	238(1162)	(4.88)
		Work >Personal	30(188)	30(197)		
		Work=Personal	58(144)	56(114)		
2 times	C: Work -> Personal -> Work	Work < Personal	2(48)	3(30)	84(791)	(9.42)
		Work >Personal	38(302)	40(407)		
		Work=Personal	1(4)	0(0)		
2 times	D: Personal -> Work -> Personal	Work < Personal	86(943)	48(488)	140(1482)	(10.59)
		Work >Personal	1(7)	2(28)		
		Work=Personal	1(6)	2(10)		
Over 3 times	E: Multiple switching	Work < Personal	73(1829)	71(1529)	324(6267)	(19.34)
		Work >Personal	76(1277)	50(1392)		
		Work=Personal	17(118)	37(122)		
Total					960(10751)	(11.2)

Table 9 Session classification distribution by switching pattern and work situation.

I categorized 960 sessions into six main patterns, taking into account the session frequency and the mean and median time. (Figure 26) The classified pattern occupies 59.27% (N = 569) of the total by frequency and 81.23% (t = 8733 minutes) of the total based on the usage time, and thus includes the majority of the analyzed objects. Sessions not included in the main pattern are classified into other types. The 960 sessions included in the classification were included in each pattern independently without overlapping.

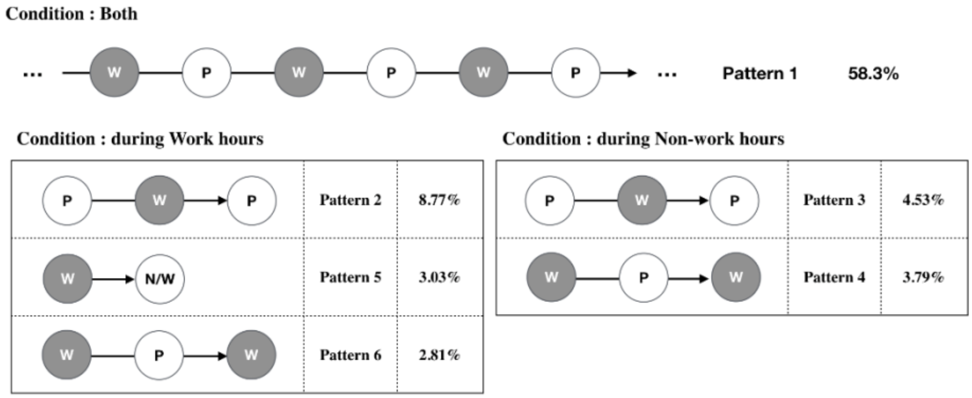


Figure 26 Heterogeneous switching type in session (Phase 2)

(1) Pattern 1. Wandering between work and personal chat (N = 324, 34.75%, t = 6267, 58.3%). This means that the user has not focused on either work or personal chats during a single period of time to turn on and use the MIM app. It was the largest part of the overall pattern.

(2) Pattern 2. Work between cyberslacking (N = 86, 8.96%, t = 943, 8.77%): This is a pattern that returns to a personal chat after a brief work chat in the middle of a personal chat during working hours. Includes 2 switching. The high percentage of personal chats in the work can be viewed as cyberslacking. In spite of switching to a work chat in the middle, the user returned to his personal chat and continued cyberslacking.

(3) Pattern 3. Interruption by work (N = 48, 5%, t = 488, 4.53%): In the after-work hour, a personal chat interrupted by the work chat for a while but returned to the personal conversation. It includes two switchings.

(4) Pattern 4. Focus on work after work hour (N = 40, 4.17%, t = 407, 3.79%): This is a pattern where a personal chat was briefly made in the middle of a work chat during the after-work hour, but then returned to the work chat. The work chat rate is higher than the private chat in session.

(5) Patter 5. Personal chat after work (N = 33, 3.43%, t = 326, 3.03%): This pattern

occurs when 1 switching occurs. This is a pattern where a long work chat is done first during work hours and then transferred to a personal chat.

(6) Pattern 6. Returning to work (N = 38, 3.96%, t = 302, 2.81%): This pattern includes two switchings. At work hour, a session was interrupted by a private conversation during a work chat, but then returned to the work conversation. The proportion of work conversation was higher than that of personal conversation.

(7) Pattern 7. Other (N = 391, 40.73%, t = 18.78%)

3) Qualitative Findings

An interview with a research participant was conducted on RQ4. The interview results are organized into three themes as follows.

(1) Inconvenience from mixed chats:

Participants felt “anxiety” (P07) or “pressure to check” (P04) when their work chat came after work, and they thought that their leisure time was violated. So, they checked the alarm for business contact, but many responded that they had delayed reading and replying to the end of their personal time.

“I think it may be important, so when I get a work chat after work, I usually respond immediately.” – P02

“I'm annoyed with work chats after work, so I just check and ignore them and read them very late at night or go to work the next day.” – P03

On personal chat during work, almost all participants experienced moments of disturbance. Receiving personal contact during work "distracted me" (P08) and "is anxious because of the accumulation of notifications in personal chat rooms" (P07).

(2) Strategies of Users

Participants used several strategies to manage the mix of work chats and personal chats. The most common way was to turn off alarms for disturbing chat rooms, mainly by trying to focus on work by turning off alarms in private chat rooms during business hours.

"When I'm busy, I turn off all personal chat room notifications and try not to check. I practiced a rule that only checked once an hour. "-P04

In addition, a large number of respondents were using the defer & scan strategy (P02-04, P06-10). This strategy first defered a reply to a personal chat that arrives during work, and then later enters a chat room in spare time. Scan the entire chat and dismiss the notification. In this process, users quickly identify and respond to what needs to be answered.

"When badge accumulates, I scroll down and see if there's anything I need to reply and turn off. I also check the preview pop-up when a message comes in to decide whether or not to enter the chat room. "– P08

There were also strategies for considering work colleagues and chat counterparts.

"I go to the bathroom and use Kakaotalk to avoid being discovered by my colleagues when I'm talking to a friend. And I always send the last message as an emoticon, so my friends won't be noticed by their coworkers because of the kakaotalk notification. "-P01

"In order to keep others from knowing I'm in a private chat, I intentionally send a personal chat while talking about work. I act as if I am at work."– P09

However, in some cases this management strategy failed due to work chat notifications. Respondents said they turned on MIM to check for work messages, and they naturally saw personal conversation notifications, or vice versa. (P01-P04, P07-P09)

(3) Effectiveness of Blocking Policy

There were many skeptical responses to blocking MIM messengers and chat rooms during and after work to prevent mixing between work and personal chat. P01 replied, "After I leave work, I have to respond to the request for necessary materials because there are still other colleagues in the office." P05 says, “Blocking itself is impossible. If your boss or team member wants to write it, you have no choice but to write it.” In addition to these responses, P07 said, “Even if Kakatalk is eliminated, colleagues or supervisors will be contacted by other means such as phone calls, texts and e-mails in case of emergency. That's why it is necessary to respond anyway. ” P08 also replied, "If policy prevents people from having private conversations with Kakaotalk, they will have a different way of doing things personally at work."

4.4. Limitations & Conclusion

In this study, I analyzed the log data recorded in the field for 30 days and 92 days over 2 phases and explored how work and personal conversations are mixed in MIM apps and their patterns. In addition, I conducted a qualitative investigation to identify the mitigation strategies participants used in this situation. I observed a mixture of work and personal conversations in MIM apps. The participants used a MIM app more in personal conversations, but they also used it for about 25% of business conversations. Also, in the switching analysis, the pattern in which users switched between work and personal conversations 3 or more times occurred most frequently. In the interviews, I found that users felt uncomfortable participating in mixed conversations and used various strategies to manage them. Based on these results, I concluded that the existing app-blocking-centered response method is ineffective. At the in-app-behavior level, micro-selective management strategies that people can use to manage work and personal conversations in more detail need to be discussed in the HCI field.

However, this study has limitations. For instance, the number of participants is relatively small, and the age group is biased. To compensate, I tried to analyze a relatively large amount of data by extending the log collection period. However, for the generalization of the research content, additional research needs to be conducted with a larger number of participants. In addition, I conducted this study with only MIM apps. Considering the situation in which a mix of work and personal behaviors is likely to appear in various apps, including email, phone calls, and text messages, it is necessary to increase the number of analysis targets for a more robust analysis. Therefore, in future studies, it will be necessary to supplement the results of this study by increasing the number of study participants.

In addition, I analyzed the switching patterns in work and personal conversations, which can occur when users mix work and personal conversations in one chat room, by collecting user-provided work and personal conversation data. However, to analyze this part accurately, it is necessary to analyze the content of the conversation in each chat room, but it is difficult to analyze the content in reality because the subjects might be reluctant to provide the data due to the nature of the app.

In addition, standards for work and personal conversations may differ between people. For example, in the case of talking about the weather in a work chat room or talking about lunch, even if it is not exactly work-related, some people may consider small talk with people at work work talk. Therefore, if the user designates himself/herself as a work chat room, it seems likely that most of the conversations in this chat room would be extensions of work or work conversations. However, ultimately, it seems necessary to think about how to analyze individual conversation log units rather than chat room units for accurate work conversation and switching analysis of individual conversations.

Despite these limitations, this study is useful, as discussions about deviance caused by the use of MIM apps at work and the problem of work conversations after work are becoming more common. In particular, this study is meaningful because I identified a more practical usage pattern by studying actual use logs.

In addition, because I specifically identified the switching patterns between work and personal conversations and users' problem-solving strategies, this study contributes to response strategies for related social problems in the future.

5. UX Strategy to Mitigate Switching Behavior in Mobile Instant Messenger

In this chapter, I conducted a study on RQ5 (“What is the effectiveness of chat prioritization as a user experience strategy for mitigating switching behavior?”) based on the research results conducted in Chapters 3 and 4. I established a UX strategy to resolve the MIM switching problem between work conversations and personal conversations and to describe the results of the examination of the effects. In Chapter 3, I revealed that smartphones and all apps are actively used for both work and non-work purposes. Furthermore, I explained that work use and non-work use were highest in MIM. In Chapter 4, I described a study that was conducted on switching between work and personal conversations in MIM, which discovered that switching within MIM occurred frequently enough to be repeated three or more times when the app was launched once. In particular, it revealed that the purpose of starting a conversation, whether for work or non-work, affects the overall character of the conversation. Based on these results, I conducted a study that proposed a strategy to mitigate switching between work and personal chats within MIM and reported the results in this chapter. Proposed method was to set temporal priority and spatial priority for communication message delivery, which I implemented in the Wizard of Oz method and tested in a real conversation situation.

I also tested and observed the effectiveness of applying this priority strategy method in real work performance situations. This chapter reports on the effectiveness of this priority strategy as a novel switching mitigation method.

5.1. Motivation

"Big rocks first" is a well-known concept in time management that means it is important to deal with important tasks first for work management [220]. However, smartphones are increasingly used not only in daily life but also at work [2], [60], [67], which has made it difficult for users to autonomously manage their priorities. Many users experience confusing multitasking situations that require them to simultaneously process numerous tasks related to personal life and work on a single device, such as checking e-mails, booking travel, listening to music and videos, posting on social media, or checking and writing documents [1], [22], [77], [221]. This problem is getting worse, particularly in Mobile Instant Messenger (MIM), which was recently established as a universal communication method. MIM has become a major tool for mobile text communication [84]. Unlike the SMS of the past, MIM has been increasingly used because of its many advantages, including free and easy photo and file transfer and group chat option [55], [154]. These characteristics can increase work efficiency, meaning MIM is widely used not only for personal purposes but also for work [167]. This has resulted in work and personal conversations being simultaneously transmitted and received within one MIM app, which has blurred the boundary between work and personal use and has made autonomous usage management difficult [198], [211], [212].

In the process of constantly switching between work and personal conversations, users are placed in an excessive multitasking situation that results in cognitive overload and reduced work efficiency [22], [222]. Several studies have revealed that group chat rooms in MIM serve as a kind of digital dwelling beyond simple message storage [154], [223], [224]. From this point of view, frequently switching and mixing between work and personal chat rooms, which have different characteristics, can cause stress by triggering the user's mind-set switching.

To solve this problem, various countermeasures have been applied and studied. In the technical field, service providers such as Apple and Google offer a function to block specific notifications by setting devices to "Do Not Disturb" or Focus mode [161], [164]. However, blocking MIM notifications will stop not only personal conversations but also work-related conversations, making the effectiveness of the blocking function inadequate. Most MIM apps provide a function to turn notifications on and off for each chat room; however, it is impossible to completely block a specific one. When the user opens the app to check unblocked conversations, the blocked conversations will also be exposed. In the academic field, strategies to reduce unnecessary notifications [84], [176], delay the notification time [156], [217], or find an optimal notification time [127], [160] have been the main focus for studies. These strategies can help reduce MIM notifications, but there is a limit when selectively managing work and personal conversations occurring simultaneously within one MIM.

I referred to these previous studies to devise and verify the effectiveness of a new message delivery strategy that deviates from blocking or delaying the use of apps or notifications. In this study, I tested the solution strategy on in-app behavior within MIM, taking into account situations where both work and personal conversations take place. Specifically, I tested a temporal priority setting method, which allows users to check non-important conversations after they first check important conversations, and a spatial priority setting method, which ensures that important conversations are always fixed at the top of the screen; the latter was implemented in the Wizard of Oz method and tested in real conversation situations. This research is an extension of the previous study on the confusion between work use and personal use of smartphones and MIMs [198], [211], [212]. Studies have reported that among smartphone apps, MIM has the highest overlap between work use and personal use; the pattern of frequently switching between work and personal conversations within a short time occupies the highest proportion. Therefore, this study aimed to explore specific UX strategies to solve these problems based on the following research questions:

RQ5. What is the effectiveness of chat prioritization as a user experience strategy for mitigating switching behavior?

- What characteristics does the priority-based message delivery strategy have compared to the existing message delivery method?

- What difference does the priority-based message delivery strategy have in performance compared to the existing message delivery method?

- What is the user's perception and qualitative evaluation of priority-based message delivery strategies and existing message delivery methods?

5.2. Phase 1: Study Design of Wizard of Oz Experiment

In this study, I propose a new management strategy based on existing studies and theories on ways to solve the mix of work and non-work conversations in MIM and conducted an experiment to verify its effectiveness. The purpose of this study was to observe how participants' conversation management differed according to the two proposed prioritization strategies and to find out how this affected work efficiency compared to existing MIM usage behavior. I observed the process participants used to switch chat rooms in a situation where they were simultaneously managing a work conversation and a personal conversation. The experiment was conducted with the Wizard of OZ methodology using the open chat room KakaoTalk to test MIM functions that did not previously exist. The experiment was designed by referring to the task-based method used in Shrot et al.'s [225] interruption study. Collecting data from interviews and surveys can include distorted memories from people, which make it difficult to capture actual behavior. Therefore, an experiment was conducted by assigning a virtual task to observe actual behavior when managing and switching chat rooms; in consideration of COVID-19 protocols, an online video conferencing program (Zoom.us) was used.

Participants received additional mini work tasks through MIM while performing document tasks and were placed in situations where they had to manage personal conversations at the same time in MIM. After the experiment was over, participants were given a survey that asked for opinions on satisfaction, convenience, usefulness, and efficiency for each experimental setting. Finally, participants were interviewed to investigate the user experience in more depth while also referring to the experiment and survey results. During the interview, in addition to asking about the experiment, they were asked about their experiences with breaking the boundaries between work and personal time due to smartphones and the countermeasures they applied to overcome this problem.

5.2.1 Participants

For this experiment, participants were recruited through an online community announcement; when they clicked on the link in the posting, they would receive information about the study, participation methods, and rewards. I only received names and contact information from participants who signed the consent form. Since the experiment process included having personal and work conversations, it was necessary to recruit personally acquainted people (friend, family member, colleague, etc.) who were willing to have private conversations while performing the task. Acquaintances of the participants were recruited through a snowballing method and set as experimental partners. The participants were informed about the study and directly selected a partner whom they usually had private conversations with to participate in the experiment. Acquaintances selected as partners were also informed about the study and required to fill out a consent form.

As stated in Chapters 3 and 4, the subjects of this experiment were knowledge workers who used MIM in their daily work. There were three major screening conditions for participant selection. First, participants had to be over the age of 18 with work experience in a company because this study observed the behavior of work and personal purposes using the MIM app on a smartphone. Second, recruited people had experience using KakaoTalk (the MIM used in this experiment) for company work. Third, the subjects were limited to knowledge workers.

A total of 20 participants were recruited (3 men and 17 women), all of whom were knowledge workers currently employed at offices. The participants' ages ranged from 1 person in their 20s, 6 people in their 30s, 11 people in their 40s, and 2 people in their 50s. The experiment was conducted in pairs. After completing the experiment, survey, and interview, all participants were paid KRW 30,000 (about USD 23) per person as a reward for participating in the study.

5.2.2 Experimental Settings

This section summarizes the specific experimental settings and conditions of this study. The subjects in the experiment participated in pairs of two and performed the main task in three experimental conditions one-by-one. The existing MIM situation was set as the control group; the remaining two experimental conditions were designed using existing task-switching studies, switching management strategies, and related theories.

For the theoretical background, Wicken's Strategic Task Overload Management (STOM) model was borrowed. He separated the variables that affect switching from one task to another into four major categories: easy, interesting, priority, and salience [226]. Among these variables, the easy and interesting categories depend the most on the characteristics of the task itself; therefore, I focused on the priority and salience categories from an interface design point of view. For Design A, the priority category was applied in such a way that the user could check specific messages first according to the priority. For Design B, the saliency category was applied to always expose the priority chat room in a fixed location. In addition, Design B reflected the research results of Monk et al. [227], who suggested that helping people recognize content related to a previous task, even if it was simple, alleviated cognitive memory collapse.

In addition to the theoretical background, both experimental conditions were designed based on the switching management strategies discussed in Chapter 2.3. First, Design A borrowed the task-inserting strategy to perform specific missions, such as button or number input, to obtain permission to use a smartphone or app.

This was applied in such a way that participants had to first check the content of the priority chat room before checking the contents of other chat rooms. It was also connected with the delay strategy because the notifications from other chat rooms were delayed until the priority chat room was checked. This priority management method was already implemented in the e-mail service by user-given labels and filtering rules; however, it was not implemented in MIM, so this aspect was borrowed to examine its effect.

Design B extended and applied MIM's pinning function at the top of the chat room to increase saliency (described above). According to Monk et al. [227], being able to confirm the contents of a previous task can alleviate memory decay. In this regard, I wanted to use a method that always fixed the chat room to the top in an open state, rather than simply fixing the position of the chat room at the top. The following three experimental settings were constructed:

Variable	Control group	Design A	Design B
Message delivery order	Last arrival	Work chat room priority	Last arrival
Fixed exposure in chat rooms	X	X	O

Table 10 Experimental Condition

- Control group: Basic "recent message first" setting of existing MIM (KakaoTalk).
- Design A (temporal priority setting): A method that adjusts the temporal exposure order of chats so that users can only check messages in non-priority chat rooms after first checking messages in the priority chat room. Since this experiment uses this method in a work situation, it was implemented in a way that did not expose personal chat rooms if new messages remained in the priority chat room during work.

- Design B (spatial priority setting): A method that the priority chat room was always open and pinned at the top of the chat list to increase the saliency and cognitively aid in resuming work.

The basic setting of this experiment was a working situation; the main task was work, and both work-related conversations and private conversations that occurred while the work was being performed were observed. Because KakaoTalk is the most used app in Korea, it was used in the experiment. In this study, each participant received the three conditions described above in a random order.

I conducted the experiment in this study in a PC environment, not on a mobile app because it was necessary to observe KakaoTalk conversations on one screen while performing work. Of course, this was a limitation for the results because an actual smartphone app was not used in this situation. To observe the situation of using MIM on a smartphone while working, it was necessary to record the smartphone use or smartphone screen as well as the PC screen performing the task. However, in this way, it was determined that researcher intervention would increase, which could interfere with data collection in a natural situation.

5.2.3 Task

The tasks performed by users in this experiment can be divided into two main categories: a document task to correct typos in documents and create work context, and a messaging task to manage business and personal conversations in MIM.

1) Document Task

The document task was given to the participants to create work context; the task was basic typo correction in order to minimize the difference in difficulty between individuals and to maximize the adaptability of the experiment [225]. The typo-correction task was performed with Google Docs, which was easily accessible with an internet browser. To eliminate the gap due to the difference in difficulty, the typo-correction contents were selected from non-literary articles in the linguistic section of the College Scholastic Ability test conducted in 2020 in Korea. The articles were geared towards a basic adult level that almost all people have encountered several times in high school. Since the consistency and level of difficulty was already verified, it was expected to be stable with very little deviation depending on the level of understanding of each participant. Typos that require knowledge on spacing and grammar were excluded as much as possible; the task mainly consisted of obvious spelling errors. A total of 3 articles were prepared with 1 article per 3 experimental conditions; 50 typos were included in each artricle.

2) MIM Task

Tasks performed in MIM were distributed based on work conversations and personal conversations. First, the researcher created a work chat room and a personal chat room using KakaoTalk's open chat function to protect personal information. This is anonymous and customizable chat room that can set the user's name freely. The main participant (1) corrected typos, (2) received additional tasks from a researcher disguised as a co-worker through the open work chat room, and (3) simultaneously had a private conversation with the experimental partner in the personal chat room.

The total experiment time for each participant was 21 minutes; each of the three conditions was performed in random order for 7 minutes. The 21 minutes were set based on the average length of mixed conversation sessions in a previous study [198]. Three additional tasks were given through MIM per condition (approximately every 2 minutes) and consisted of simple missions, such as changing the text color and counting sentences.

While the main participant was performing a work task, the partners were instructed to invite the main participants to go on a trip with him/her and to discuss and choose a place to schedule. In the personal conversation, only a vague topic was given and no specific guide to chat were provided to elicit their natural conversation.

5.2.4 Procedure

The researcher discussed the experiment schedule with the participants, guided them to install the KakaoTalk app on the PC in advance to participate in the experiment, and delivered the Zoom link for the experiment. The three experimental conditions were conducted in random order. After both participants completed the task experiment, questionnaires and in-depth interviews were conducted. The experiment was carried out in approximately 1 hour and 40 minutes for each pair.

The experiment was conducted using the Wizard of Oz method. In the case of Design A, it was not possible to create the desired conditions by opening a chat room in the conventional way because the timing of message delivery had to be controlled. The work conversation was a chat room where the experiment participants and the researcher had direct conversations. However, in the private chat rooms, the researcher created an open chat room for each participant's personal conversation to control the timing of the conversation (Design A). In Design A's private chat room, participants were led to believe that they were talking directly to their partner; the researcher accomplished this by pretending to be their partner and using the partner's name. The participants were notified of the experimental settings after the experiment was completed.

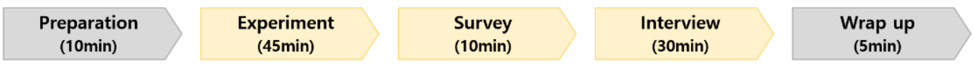


Figure 27 Experimental protocol

1) Preparation: Check the environment settings to verify that the connection and screen sharing of the online video conferencing program work well. Guide the research, explain the experiment process, and obtain consent for recording.

2) Experiment:

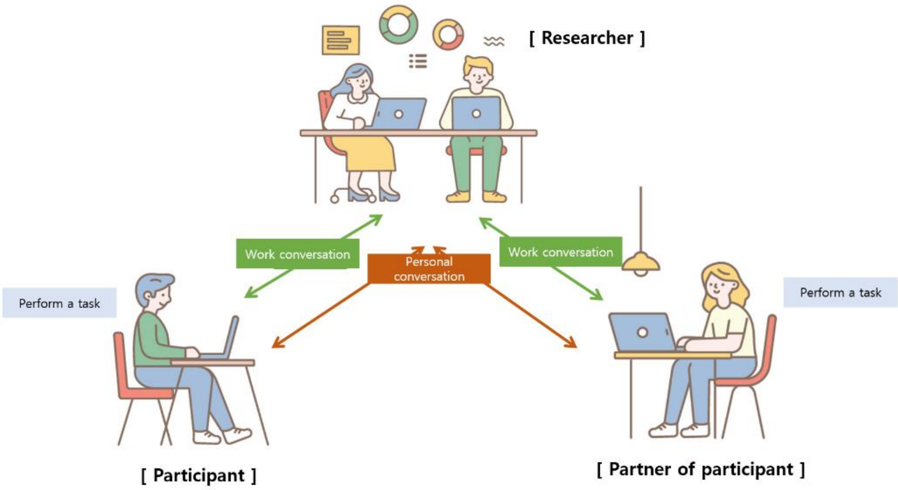


Figure 28 Experimental setting using the Wizard of Oz methodology. Personal conversations were conducted through researchers.

(1) The main participant handles typographical corrections and receives additional work tasks (simple tasks such as changing font color or dividing paragraphs) from the researcher in the MIM work chat room. For each condition, one document is corrected for about 7 minutes, and then three additional work tasks are received. During this process, the participant will receive a private message from the partner.

(2) The three experimental conditions are provided in a random order, and the participant performs them one-by-one.

(3) After performing this process for about 21 minutes, the roles are changed; the partner proceeds with the document work while the participant leads the personal conversation for about 21 minutes.

3) Survey: A survey was conducted to quantitatively evaluate the user experience and work efficiency of the experimental conditions. After the experiment was over, the participants filled out a survey. Among the scales commonly used in user experience and usability evaluations, 4 items were selected for the context of this experiment. A questionnaire was conducted for each of the three experimental conditions [228–230]. All questionnaires were evaluated on a Likert 7-point scale. The questionnaire items are as follows. (1) Useful: Did the setting help you perform your job? (2) Effectiveness: Did the setting help you focus on your work? (3) Efficiency: How much did the setting interfere with your work? (4) Satisfaction: Are you satisfied with the setting?

5.2.5 Data Analysis

1) Quantitative Analysis

For quantitative analysis, statistical analysis was performed on time-based data derived from analyses of the video recordings of the experimental process, MIM log data, typographical correction data, and surveys. The purpose of this study was to determine whether there were any significant differences between each experimental condition group. A one-way repeated measure, ANOVA, was used to analyze significant differences between the three groups. Tukey’s HSD was performed as a post hoc test. The variables used in the analysis are summarized below. (Table 11)

2) Qualitative Analysis

To conduct a qualitative analysis of the interviews, all interview contents were transcribed and analyzed using thematic analysis method [231]. To derive key concepts and themes, two researchers conducted open coding for each interview script. Researchers were grouped by topic and discussed the contents of each coding, resulting in four significant findings.

Variable	Description
Total number of messages	Total number of work and personal chat messages sent and received during the experiment.
Personal messages	Number of private chat messages sent and received during the experiment.
Work messages	Number of work conversation messages sent and received during the experiment.
Switching after conversation ends	Number of cases where one chat room was closed and moved to another chat room. Only heterogeneous switching from work conversation to personal conversation or personal to work conversation.
Drop-out	Number of cases where the conversation was moved to another chat room without closing the chat window.
Check non-priority (personal) conversation first	Number of times when a personal message was opened and checked first when both a work message and a personal message notification were presented.
Duration of notification response	The time it took to open the chat window after the message notification (badge) arrived.
Duration of conversation	The amount of time it took to open a chat room once, the duration of the conversation in the chat room, and the amount of time it took to close the window.
Typo-correction rate	Proportion of accurate corrections out of 50 total typos in experimental work documents.

Table 11 Analysis Variables

5.3. Phase 1: Quantitative Findings

5.3.1 Descriptive Analysis

The total number of messages collected from this experiment was 2530; the main participants sent 842 messages (33.3%) and received 1688 messages (66.7%). In addition, 1666 (65.8%) personal messages and 864 (34.2%) work messages were collected. The table above shows the results of the collected received and sent messages for private and work conversations for the a) control group using the basic KakaoTalk settings, b) temporal priority setting group, and c) spatial priority setting group.

	Control Group	**Design 1 Temporal prioritizing**	**Design 2 Spatial prioritizing**	**Total**	**F**	**P (0.05<P)**
Total number of messages	977 (38.6%)	669 (26.4%)	884 (35%)	2530	5.268	0.008 *
Personal messages	622	408	636	1666 (65.8%)	4.045	0.023 *
Received	395(63.5%)	269(66.1%)	425 (67%)	1089	2.868	0.065
Sent	227(36.5%)	139(33.9%)	211 (33%)	577	2.785	0.070
Work messages	355	261	248	864 (34.2%)	6.377	0.003 *
Received	256(72.1%)	178(68.2%)	165 (66.5%)	599	9.245	0.000 *
Sent	99 (27.9%)	83 (31.8%)	83 (33.5%)	265	0.935	0.398

Table 12 Descriptive Statistical Analysis and Comparison of Averages for Each Experimental Setting

Among the three experimental settings, the control group had the highest number of messages; the spatial priority setting had the second highest number, whereas the temporal priority setting had the lowest number of messages.

5.3.2 Switching Behavior Analysis

As I conducted this study under the assumption of a work situation, I analyzed the results under the assumption that personal messages were a hindrance factor. In addition, I assumed and analyzed only the case of heterogeneous switching from a work conversation to a personal conversation and from a personal conversation to a work conversation as switching behavior.

As a result of the analysis, the user's switching behavior can be divided into three main categories; (1) switching after a conversation ends, in which case where one chat room is closed, (2) drop-out, which is moved to another chat room without closing former chat room, (3) checking the non-priority (personal) conversation first, which opens a personal chat first without checking the work chat to see if both work messages and personal message notifications have arrived.

1) Switching After Conversation Ends

Switching after a conversation ends means a case where one chat room is closed and moved to another chat room. I performed an ANOVA analysis to compare the averages of the three groups. The average number of switching behaviors showed a significant difference by setting group. The control group had the highest (avg=6.3), followed by the spatial priority setting (avg=5.35), and then temporal priority setting (avg=4.05), which decreased in order ($F=3.354$, $p=0.042$*). However, only the difference between the control group and the temporal priority setting showed statistical significance.

To examine in more detail the circumstances under which these average differences between groups occur, I performed an ANOVA analysis by separating the switching after the conversation ends from the work conversation to the personal conversation and from the personal conversation to the work conversation. As a result, there was no difference by group in the case of switching from the work conversation to the personal conversation, and a significant difference was found only in the case of switching from the personal conversation to the business conversation (F=4.216, p=0.02*).

Figure 29 Average number of switches after termination between groups

Considering the average number of switches, one can see that switching behavior itself decreases the most in the case of the temporal priority setting. As in overall switching, the tendency was the highest in the control group and lowest in temporal priority setting both when moving from a work conversation to a personal conversation and from a personal conversation to a work conversation. In particular, in the case of switching from a personal conversation to a work conversation, I found that the temporal priority setting was significantly lower than that of the control group.

2) Drop-out

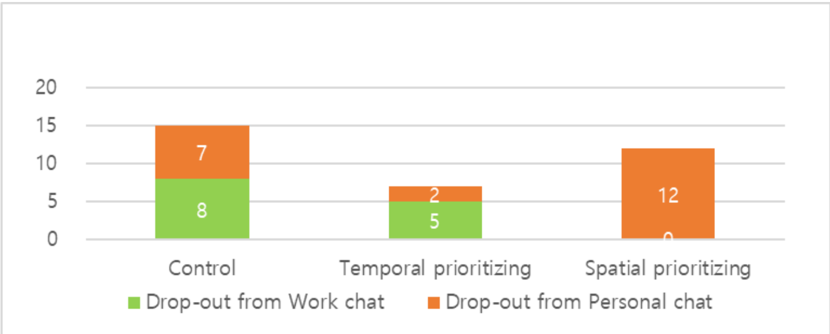


Figure 30 Cumulative number of drop-outs by group

Drop-out is the second type of switching; in this case, one conversation goes to another conversation in the middle without the user closing the dialog window. The average cumulative drop-out was the highest in the control group at 15 times, followed by 12 times in the spatial priority setting and seven times in the temporary priority setting, when both cases of drop-out in the work and personal conversation were combined. There was no difference between the groups in the total drop-out, which is the sum of both drop-out from work and personal conversations.

However, there was a significant difference by setting group in both the cases of drop-out in the work conversation (F=3.709, p=0.031*) and the case of drop-out in the personal conversation (F=3.721, p=0.030*). The graph above shows the average number of drop-outs for work and personal conversations for each setting. In the control group, the most frequent drop-out occurred in the personal conversation before the end of the work conversation, followed by the temporal priority setting, and this drop-out phenomenon did not occur in the spatial priority setting. As a result of ANOVA analysis, only the difference between the control group and the spatial priority setting was statistically significant.

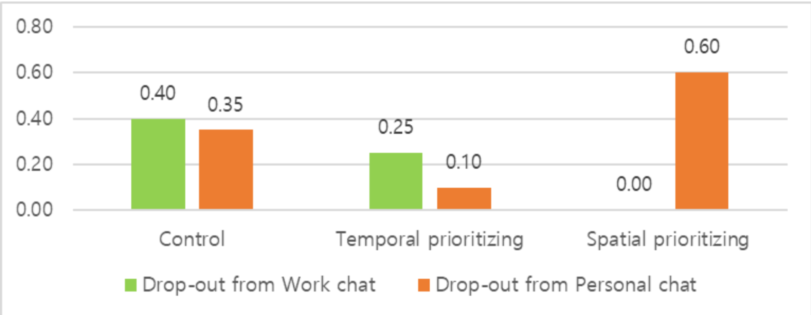


Figure 31 Average number of drop-outs from work conversations and personal conversations between groups

It is interesting that the drop-out from the work conversation occurred more in the temporal priority setting than in the spatial priority setting. The basic premise of the temporal priority setting was to expose a delayed personal conversation notification when the chat room was closed after a business conversation. Nevertheless, a drop-out occurred from the work conversation. This number is the confirmation of private messages that had already arrived before the opening of the business chat window. Conversely, in the spatial priority setting where the work chat was always fixed, drop-out did not occur from the work conversation. In the case of a personal conversation drop-out, which moved from personal conversation to work conversation, the spatial priority setting was the highest, followed by the control group and the temporal priority setting as the lowest.

3) Checking Non-Priority (Personal) Conversation First

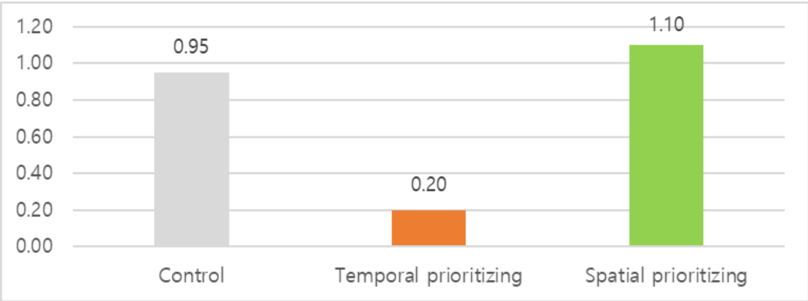


Figure 32 Number of priority checks for personal conversation by group

I analyzed the switching behavior to see which conversation was opened first in a work context when both a work message and a personal message notification arrived. As a result of comparing the number of preference choices for a personal conversation in the work situation, the difference between groups was significant ($F=3.684$, $p=0.031$*). The lowest was the temporal priority setting (avg=0.2), followed by the control group (avg=0.95). The spatial priority setting (avg=1.1) was the highest.

I also looked at the percentage of conversations each group chooses when both business messages and personal message notifications arrive. As a result, in the temporal priority setting, the choice of personal conversation was 21%, the choice of work conversation was 79%, and the ratio for choosing the work conversation was the highest. In the control group, personal conversations were 41%, and work conversations were 59%, and in the spatial priority setting, personal conversations were 36% and work conversations were 64%. Through the analysis results, I found that not only were the average number of selections of personal conversation the lowest in the temporal priority setting but that the ratio of preferentially selected work conversations was high in the weight of selection.

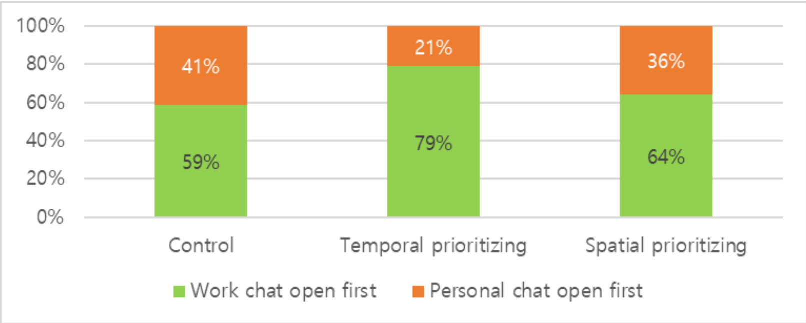


Figure 33 Rate of checking personal conversation first by group

5.3.3 Duration Analysis

About duration, I analyzed two things: (1) how long it took between the arrival of a message notification and the opening of the chat window, (2) how long the conversation lasted between the opening and closing of the chat window.

1) Notification Response Duration

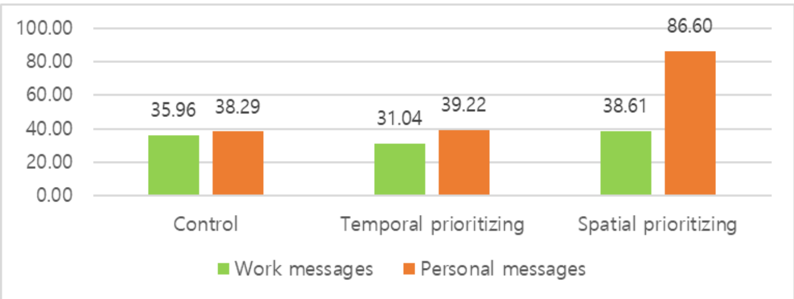


Figure 34 Average notification response time between groups (s=second)

This indicates the average time from the arrival of a notification to the opening of the chat window. As a result of the analysis, there was no difference in the reaction time to the notification of the work conversation by group (F=0.285, p=0.753), but there was a significant difference in the reaction time to the notification of the personal conversation (F=3.772, p=0.029*). In the case of the business conversation, it took 31.04 seconds in the temporal priority setting to open the notification the earliest, followed by 35.96 seconds in the control group and 38.61 seconds in the spatial priority setting. The time taken to open the personal chat window was 38.29 seconds for the control group, 39.22 seconds for the temporal priority setting, 86.6 seconds for the spatial priority setting.

2) Duration of Conversation

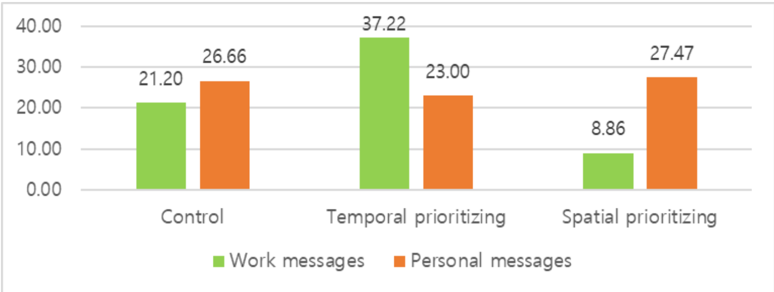


Figure 35 Time spent in chat rooms for each group

I analyzed how long the participants stayed in their chat rooms by calculating the time it takes for them to open and close the chat room once. There was no significant difference in the time spent in the personal chat room by group (F=0.396, p=0.675), and there was a significant difference in the time spent in the work chat room (F=6.243, p=0.004*). First, in the temporal priority setting, the duration of the work conversation was the longest with an average of 37.22 seconds, followed by the control group (avg=21.2), and finally, the work conversation time was the shortest in the spatial priority setting (avg=8.86). In particular, in the spatial priority setting, the average time of a work conversation was found to be statistically significant. As a result of this, it can be seen that in the spatial priority setting, one can check the contents of work or instructions without closing the chat room, so it is easier to return to the work document than in other settings. On the contrary, there was no statistically significant difference between the three groups in the private conversation.

5.3.4 Task Achievement Analysis

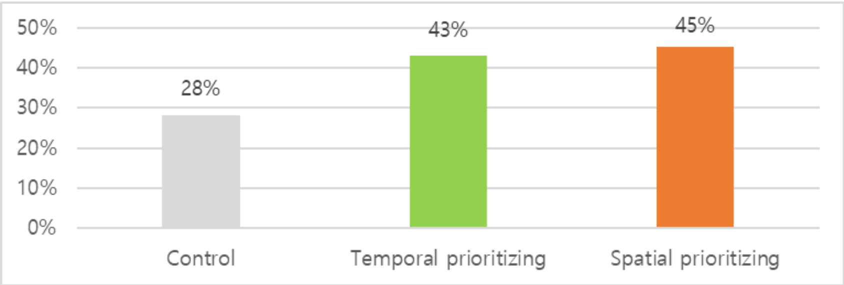


Figure 36 Error correction rate for each group

The performance of the participants was analyzed by calculating the error correction rate to ascertain how the setting of the experiment actually affected the performance of the task.

The error correction rate was derived by calculating how many of the 50 typographical errors in the experimental document were corrected by each participant. As a result of ANOVA analysis, there was a significant difference between the setting groups (F=7.703, p=0.001*). The error correction rate was the highest at 45% in the spatial priority setting, 43% in the temporal priority setting, and the lowest in the control group at 28%. This result shows that both the temporal priority setting and the spatial priority setting show higher performance than the control group, which is the existing MIM setting.

5.3.5 Perception of Users

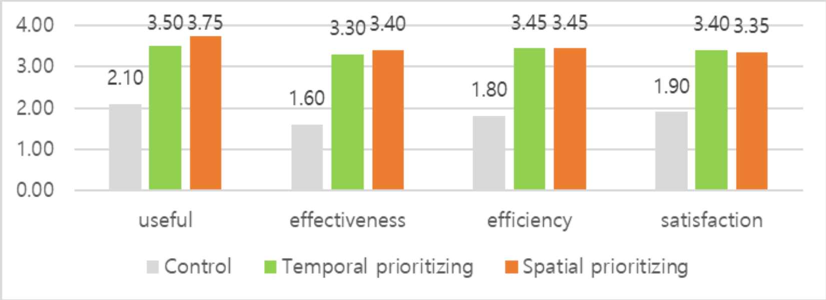


Figure 37 Average user perception rating points for each group

Previously, I analyzed objective measures such as the number of incoming and outgoing messages, number of switches, duration, and error correction rates. To investigate user perceptions and attitudes, which are subjective measures, I administered a questionnaire after the experiment. Among the scales commonly used in user experience and usability evaluation, four questionnaire items were selected in consideration of the context of this experiment.

(1) Usefulness: Was the setting helpful in performing the job?

(F=19.367, p=0.000*)

(2) Effectiveness: Did the setting help you focus on work?

(F=24.406, p=0.000*)

(3) Efficiency: How much did the setting interfere with performance?

(F=21.070, p=0.000*)

(4) Satisfaction: Are you satisfied with the setting?

(F=17.549, p=0.000*)

In the results of the ANOVA analysis, there were significant differences by group for all four items. The control group scored the lowest in terms of usefulness, effectiveness, efficiency, and satisfaction compared to the temporal and spatial priority settings. These results indicate that the evaluation results for the temporal and spatial priority settings suggested as an alternative to solving the switching problem have better usability and user satisfaction than the existing MIM. In the case of the spatial priority setting, usefulness and effectiveness received slightly higher scores than the temporal priority setting, but the temporal priority setting showed slightly higher satisfaction. However, there was no significant difference between the temporal and spatial priority settings.

5.4. Phase 1: Qualitative Findings

In this study, I conducted 10 groups (N = 20) of non-face-to-face group interviews. Each group consisted of two people who participated in Wizard of Oz sessions together. The interview results were organized into the following four themes.

1) Conversation Mix and Strategy

All participants responded that they were experiencing a mix of work and personal conversations while using MIM in daily life. First, in a work situation, they responded that even if they tried not to see personal messages, more arrival notifications piled up, making them “feel anxious to check” (P16), “confused” (P03), and “a lack of concentration on work” (P09, P10, P12). It was also said that there were times when the chat room was confusing, and the message was sent incorrectly (P11, P12).

“When I open the MIM for a work message, I subconsciously see the personal message as well.” – P11

“During work, I respond to personal messages if even simply. I am worried that the other person will wait.” – P02

As for work conversations after work, participants responded that there was “a consensus that they should not do it implicitly” (P06, P18), so sending messages to work contacts was “disrespectful and inconsiderate” (P09, P10), “interrupting leisure time” (P19, P20) and “stressful” (P15). Nevertheless, they responded that they checked as quickly as possible because of “anxiety that this could be an urgent work matter” (P03, P04, P13). Participants responded that this confusion and discomfort increased further under COVID-19. This is because as non-face-to-face work increases, both work and personal messages increase, making it more difficult to manage. Eventually, work and personal conversations “interrupted each other” (P07) more frequently.

“When I work at home, I have to keep an eye on the mobile messenger because every contact can be important.” – P04

“I am afraid I will be contacted about the quarantine or infection status, so if I get a call even at dawn, I check it right away” – P13

Participants were using various strategies to cope with this problem. The most commonly used strategy was “pending,” which delays checking and responding to messages. “If I check my personal messages during work, I feel like I have to keep talking without stopping” (P01, P05, P06, P08), and “If it is known that I checked my work messages after work, I feel pressure to do it right away” (P02, P07).

“Once I start, I have to keep answering, so I postpone it and then reply at once later.” – P04

“I check my personal messages after work, during lunchtime, or during work whenever I have a free time.” – P08

Some participants used other bypass strategies to check the message because they were anxious if they did not check it even after recognizing that the message had come. They answered that if they had a personal conversation in the middle of their work and returned to work, they would forget how far they had progressed or lose their concentration. Therefore, to prevent this, before checking personal messages, they responded by “checking the progress of the work and leaving an indication” (P04, P15). Alternatively, some participants set sounds and notifications differently for urgent contacts or a contact that must be received.

“Because I always forget how far I've been working before we talk… I mark and turn on the messenger” – P04

“My son lives in a dormitory, and we have limited access to him, so we have to respond to his message in priority. So, I set the sound differently for my son's contact and answer it no matter what, even if I'm at work” – P15

Participants adopting a more aggressive strategy were filtering work messages coming after work “by keeping their personal numbers private” (P01, P02, P05, P06, P09, P15, P16, P19). They asked senders to contact them through work apps and responded that they checked at convenient times. They replied that although they were contacted after work, they were comfortable preparing themselves and checking when they could afford to answer (P5).

However, these strategies also have limitations. No matter how late the response is, it is difficult to concentrate once one recognizes the notification. This is because one may worry whether it is an urgent contact. In addition, even if an official channel is used so as not to disclose a personal number, if the participant responds to the work message, the personal number will be released anyway (P15). Many participants acknowledged and resigned that they had no choice but to accept such mixed-chat situations (P01, P03, P04, P07, P09, P11, P12 P15, P17, P18, P19).

“If someone knows my number, it seems more difficult not to contact me. And more and more, of course, that person will contact me on non-essential matters.” – P17

2) Blocking and Separation: An Unrealistic and Inhumane Violation of Freedom

All interviewees showed negative reactions to blocking and separation policies, which are often discussed as ways to resolve the confusion between work and personal conversations. Analyzing the participants' responses, these policies can be divided into three main categories:

First, the majority of opinions were that it was not realistic in terms of effectiveness. They do not think that people will follow blocking policy (P18), and it is fundamentally impossible to separate from work completely (P13, P17). They also answered that even if the company creates a business channel, they may still be contacted through their personal smartphones (P09). This limitation of effectiveness was mentioned in the interview for the previous study.

"People don't just play one role. Is it possible to cut out 24 hours and play the role of an office worker for this amount and a family member for this amount?" – P17

Second, these policies are not conducive to work efficiency. As mentioned, if one cannot check personal messages at all, one will be anxious and will not be able to work anymore (P02, P04, P07, P08). In addition, they answered that it is inefficient to block them altogether because they must be contacted if something important happens after work (P07).

Interestingly, many answered that these blocking and separation policies are inhumane and infringe on individual freedom (P06, P07). Participants said, “No way” (P08), “We are not slaves to the company. I would reject it if it were me” (P09) and “It's inhumane” (P10). Participants said the policy direction was not humane and that the company had no right to restrict individual messenger use.

“I`m not just a worker. I am also the mother of my children.” – P02

"Just because I work doesn't mean I have to ignore personal and family affairs." – P18

"Personal Kakao Talk messages are disruptive but valuable conversations." – P11

3) Evaluation of Experimental Settings

All participants answered that they were able to focus on their work better than the existing KakaoTalk messenger setting (control group) and were satisfied with both the temporal and spatial priority settings.

First of all, most of the opinions on the existing KakaoTalk setting were that they were too busy and could not concentrate on their work (P03, P04, P11, P12, P13, P14, P17, P18). They also said that it was almost impossible to work simultaneously while replying to private messages (P13, P17, P18), and they recalled continuing private conversations while working (P07).

"It was so mixed up that I got annoyed afterward" – P09

"I usually made a mistake while having a personal conversation in the middle of work" – P12

I also found that notifications increased the cognitive load. They only wanted to have a work conversation, but when running a MIM, they can see private messages (P14), and they should see them the moment they know a new message has arrived (P17). Finally, the responses that complained about the difficulty of returning to work stood out. Participants answered that they hard to remember the contents and area they work before switching. (P01, P02, P13, P14, P17, P20).

"It was difficult to switch thoughts, so it was difficult to keep up with the task when there was a lot of switching." – P19

They said that they were hard to retaining memories of work and that it took a long time to re-capture the work context. They said that they would not be able to quickly change their status to the so-called "work mode".

In contrast, most of the participants answered that they liked to work in the temporal priority setting. They were able to concentrate better naturally as they dealt with work conversations first (P05, P06), they were psychologically most comfortable receiving notifications for personal conversations after the work conversation was over (P11), and they did not see notifications that a personal conversation was coming, so they could focus more on their work.

"It was more comfortable to see the personal conversations after completing the work, rather than alternating between work conversations and personal conversations" – P12

Of course, there were also some negative comments about these settings. Some answered that they felt burdened with processing because they received too many personal messages at once—messages that had been delayed while working according to their temporal priorities (P07, P09).

The opinions of the partners who had private conversations were interesting. Due to the characteristics of temporal priority settings, the partner who sent the notification of a private conversation recognizes that the other party has not checked their conversation for quite some time. KakaoTalk messenger can check how many people have read the messages it sends. In the case of a 1:1 conversation, the number "1" does not disappear in the chat bubble UI unless the other person confirms the chat. They responded that they could feel that "this person is busy right now" even if the other person did not have to speak and naturally started talking less (P01, P03, P05, P06, P07, P08).

Last, regarding the spatial priority setting, respondents answered that they were able to concentrate on their work the most (P01, P02, P04, P15, P16, P19, P20).

They said that they deliberately put off personal conversations because the work chat room was still visible (P04), it was easy to come back after a personal conversation (P10), and it was easy to return to the work context.

"It was easy to get back to work immediately after having a personal conversation because I kept seeing what I had to do and what I was doing." – P10

"It was easy to follow the flow because I was able to catch up on the work quickly." – P17

These interview responses support the reduction in recovery costs when switching in the spatial priority setting both in the subjective perception of users and in the objective performance score. In addition, according to the memory for goals model [227], continuing to show the primary goal (work, in this experiment) was helpful in maintaining and revitalizing the memory of the previous goal even after doing other work.

4) The Attentional Attraction of Personal Conversation

In particular, through the interview after this experiment, I found that personal conversations have a stronger attracting power than work conversations. Some participants in the interview said that the temporal priority setting was better for focusing on work than the spatial priority setting.

Even if one tries not to look at personal messages, the ringing of a notification rings already means that concentration on work disappears (P02, P04, P05, P16). During a personal conversation, when a job notification came, they checked it with a sense of duty, but they answered that they were curious if they did not see the personal conversation (P01), and that they were interested and concerned (P11) because it was fun (P02, P07, P08).

I also found that when switching occurs between work and personal conversations, the recovery costs of switching are likely to be less in personal conversations. For most participants, personal conversations are more memorable (P9, P10, P11, P12, P19, P20), and because they are interesting and routine, there is no difficulty understanding the content even if one catches it in the middle (P1, P2, P6, P1, P2, P6, P8, P18). Many answered that they could catch up with the previous content more easily.

5.5. Phase 2: Field Study Design

I previously verified the effectiveness of the priority strategy as an alternative for solving the problem of switching between work and personal conversations in MIM through an experiment using the Wizard of Oz. Looking at the analysis of the results, I found that the two strategies were better than the existing MIM in terms of reduced switching frequency, high task performance, and user satisfaction. However, it was necessary to conduct a field study to explore whether this strategy was effective in real-world settings. Therefore, I applied the priority strategy to real work situations and observed it.

I assigned experimental settings using the temporal priority strategy, the spatial priority strategy, and the existing MIM method so as to be identical to the Wizard of Oz experiment, and I observed how the participants' conversation management changed according to conditions. To implement the priority strategy, I utilized the window position and top fixing function of the PC version of the messenger. Three experimental settings were randomly assigned to each participant every hour, and the participants had natural work and personal conversations in the usual situations where they were actually working with a PC. After the experiment, user interviews were conducted to understand the user experience and satisfaction of the subjects.

5.5.1 Participants

In the studies conducted in the phase 1, I selected adults who own and use smartphones and office workers who use PCs and MIM for work. However, in the field study, there was a limit on recruiting users who were working in general companies due to security issues because the contents and processes were inevitably disclosed while using MIM, observing the situation, and collecting data during actual work. Considering these limitations, I conducted a study with five graduate students conducting an industry-university project through convenience sampling to observe the use of MIM in a real work environment. Although they were graduate students, they commuted and worked between 9 and 6 o'clock, worked on cooperative projects, and worked with general office workers. Their official positions and duties were fixed.

I recruited a total of five subjects. They were graduate students working on the same project—one male and four females. The experiment was carried out over one day and lasted for 6 hours excluding lunch break. After the experiment, I conducted an interview for 30 minutes per subject. I paid each participant KRW 30,000 as a reward.

5.5.2 Experimental Settings

This chapter summarizes the experimental setting of the field study. In this field study, I conducted the experiment in a PC environment, without using a mobile app, as in the Wizard of Oz experiment. The experimental condition reflecting the priority strategy was the same as in the previous Wizard of Oz. As can be seen in Table 10, the main independent variables were message delivery methods and chat room fixed exposure. Depending on whether or not these variables are applied, the experiment was designed with three sets: (1) a control group that remains the same as in the existing MIM; (2) design A (temporal priority design), where personal conversations can be checked first; and (3) design B (spatial priority design), where the work chat room is always exposed.

I implemented a temporal priority strategy by adjusting the location of the application window in the PC version MIM (KakaoTalk). Figure 38 below shows the setting screen used in the experiment. Unlike the Wizard of Oz experiment, the number of work and personal chat rooms was not limited, and the conversation was naturally held in the environment that participants used.

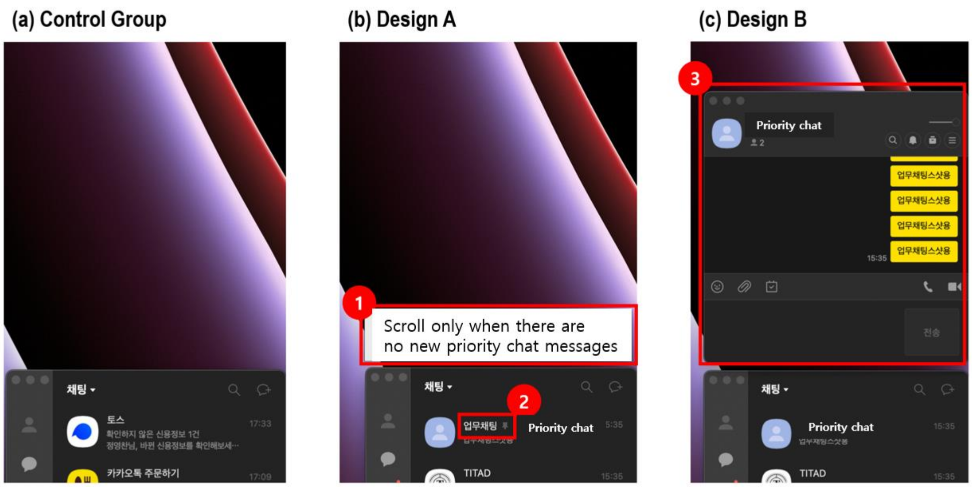


Figure 38 Example of experimental condition for field study: (a) MIM of the existing PC version; (b) temporal priority strategy setting. ① is a reminder related to the experiment; ② is fixed at the top so that the priority chat room (work) notification is shown f

5.5.3 Procedure

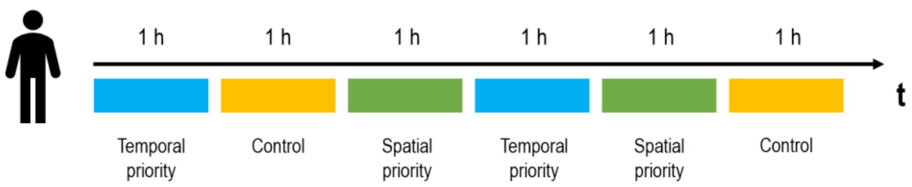


Figure 39 Experimental setting of the field study

1) Preparation: Prior to this experiment, a preliminary session was held with the subjects to guide the necessary infrastructure environment, such as explaining the research and an online video conference program (using Zoom in this study), installing a Kakao Talk PC version, and conducting experimental rehearsals. Participants were also notified in advance that all experimental processes would be recorded, and consent was obtained.

2) Experiment: Participants were instructed to participate in the experiment for 6 hours and to replace the three sets of control, temporal priority, and spatial priority every hour. The order of the setting was randomly assigned to each subject differently. Both work and MIM use scenes were recorded and used for analysis. However, if the entire PC screen is recorded, it can serve as a significant intervention in the work situation, and all personal conversations can be exposed. This can lead to resistance from users, so only the minimum range of observation as to whether the chat room is open or not was recorded (Figure 40).

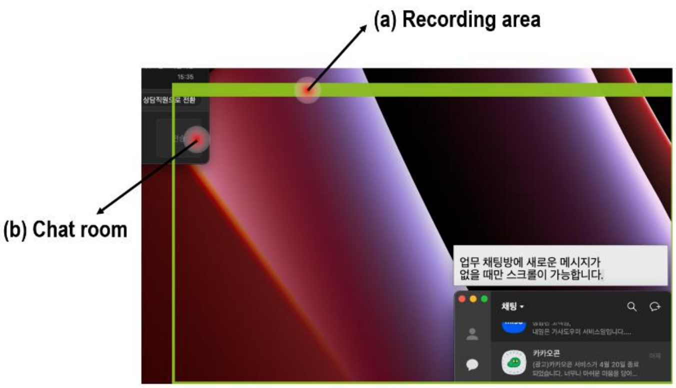


Figure 40 Screen recording example. (a) Specify the minimum area for experimental analysis as the actual recording area visible to the researcher; (b) checkable when the chat room is opened

3) Interview: Interviews were conducted for each participant to gather user experience and opinions on the experimental setting and the entire process. The interview was conducted as a semi-structured interview for about 30 minutes per person.

5.5.4 Data Analysis

Usage logs and interview data collected through field studies were analyzed in a qualitative and quantitative manner.

1) Quantitative Analysis

All experimental processes were recorded in the same way as previous experiments using the Wizard of Oz method. Two HCI researchers coded and cross-validated the video for time stamps of arriving in chat, opening chat rooms, and ending chat rooms. The time-based log data collected in this way were cleaned by excluding low-density usage sessions (e.g., sessions in which only one log was recorded). In the case of a session in which only one log was recorded, the number of transitions in the session or the number of message selections was all recorded as 0, which excessively lowered the average value of the entire session. To remove these outlier sessions, I set the session interval based on break (more than 5 minutes), similar to the rules of previous studies [209] and Chapters 3 and 4 of this study. Based on this, sessions with only one event log were excluded from the analysis, and sessions with no switching behavior were excluded from the switching analysis process.

Statistical analysis was conducted on the collected time-based log data. However, when looking at the data to compare the mean differences between the three experimental conditions, the difference in sample sizes (total number of arriving messages) for each condition was large. Because this may cause distortion in comparing the characteristics and patterns of sessions in each experimental condition, it was corrected by applying weights. The weights are based on the average of the total number of message arrivals added to work and personal messages for each condition (w_t=3.5, w_s=1.8, w_c=5.8, t=time priority, s=space priority, c=control group). I assumed that a similar number of total messages arrived for each experimental setting and analyzed the following factors: average number of switching, average drop-out, average time from notification arrival to message check, and the average time actually stayed in the chat room. All analysis units compared the average value per session in the same way as the analysis method of the previous studies. One-way repeated measures ANOVA was used to verify whether there was a significant difference between each experimental condition group, and Dunnett T3 was performed as a post-test. As in the Wizard of Oz experiment in phase 1, the independent variable is the experimental condition, and all the dependent variables are same except for the total number of messages, personal conversations, task conversations, and typo-correction rates (Table 11).

2) Qualitative Analysis

The qualitative analysis of the interview was also analyzed in the same way as the previous Wizard of Oz experiment. After transcribing all the interviews, two researchers conducted open coding for each script using thematic analysis. They found several themes by discussing and grouping based on each coded content.

5.6. Phase 2: Quantitative Findings

A total of 992 logs were collected. A total of 32 sessions were derived through cleansing, and all statistical analyses were conducted within the data contained in this session.

The 32 sessions consisted of 10 in the control group, 15 in the temporal priority set, and seven in the spatial priority set, and the average length of each set was 616.6 seconds in the control group, 850.9 seconds in the temporal priority set, and 1534.3 seconds in the spatial priority set. The average number of talk event logs per session was 17.1 in the control group, 27.2 in the temporal priority setting, and 63 in the spatial priority setting. Finally, the total number of arrival messages collected for each setting was 48 (17.6%) in the control group, 119 (43.6%) in the temporal priority setting, and 106 (38.8%) in the spatial priority setting.

	Control Group	**Design1: Temporal prioritizing**	**Design2: Spatial prioritizing**	**Total**	**F**	**P (0.05<P)**
Number of Sessions	10	15	7	32		
Average usage time for each session (seconds)	616.6 (SD=225.0)	850.9 (SD=711.0)	1534.3 (SD=871.1)	812.0	14.233	0.000 *
Total number of messages arriving	48 (17.6%)	119 (43.6%)	106 (38.8%)	273	14.605	0.000 *
Personal messages	24 (14.4%)	67 (40.1%)	76 (45.5%)	167	12.066	0.000 *
Work messages	24 (22.6%)	52 (49.1%)	30 (28.3%)	106	4.444	0.014 *

Table 13 Descriptive Statistics for Each Experimental Setting

As can be seen from the table above, in this case, there was a large difference in the sampling size of the arrival message, which can be said to be the basic unit of analysis, for each experimental setting. Weights were applied for proper comparison. The weight was derived by dividing the average of the number of arrival messages per session by the average value for each setting ($w_c=5.8$, $w_t=3.5$, $w_s=1.8$, c=control group, t=temporal priority, s=spatial priority). After that, all ANOVA analyses were performed with this weighted value.

5.6.1 Switching Behavior Analysis

The overall analysis frame was the same as for the Wizard of Oz method performed previously. Similarly, in this field experiment, only the cases of heterogeneous switching, not homogeneous switching, were counted for “switching” an analysis target.

1) Switching After Conversation Ends

This usage behavior means switching to the next conversation after finishing one conversation in one session. The switching mean was 6.00 (SD=2.21) for the control group and 3.67 (SD=3.23) and 9.57 (SD=8.94) for the spatial priority setting, indicating the highest switching behavior in the spatial priority setting (F=13.698, p=0.000*). As a result of comparing the case of switching to a personal conversation after a business conversation and the case of switching to a business conversation after a personal conversation, I found there was a significant difference for each group in both types of switching. In the type of switching from a work conversation to a personal conversation, the temporal priority setting was the lowest with an average of 2 (SD=1.475), the control group had the highest setting of 2.8 (SD=1.550), and the spatial priority setting had an average of 4.86 (SD=4.604) (F=10.321, p=0.000*). The results were similar when switching from a personal conversation to a work conversation. Temporal priority setting (avg=1.67, SD=1.831), control group (avg=3.2, SD=1.260), and spatial priority setting (avg=4.71, SD=4.372) were found to be high in the order (F=15.033, p= 0.000*).

Figure 41 Average Number of Switching After Conversation Ends By Switching Type between Groups in a Field Study

The results of the switching behavior analysis show that the temporal priority setting has the effect of reducing the switching behavior. The biggest difference from the experimental results conducted through the Wizard of Oz method was that the spatial priority showed more switching behavior than the control group.

2) Drop-Out

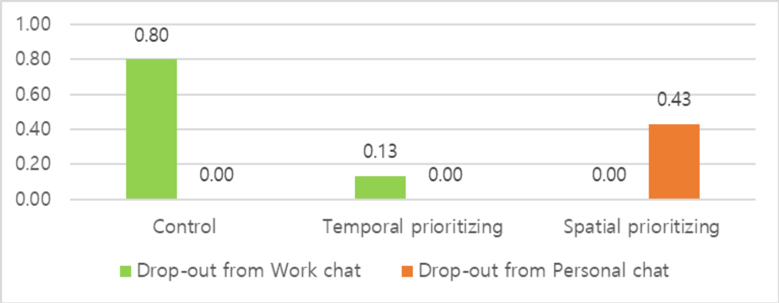


Figure 42 Average number of drop-outs between groups in field study

The second type of switching behavior, drop-out, is a case in which one conversation goes to another without ending the chat room. In the field study, as in the Wizard of Oz experiment, there were not many cases, but as a result of the analysis, the average number of drop-outs between each group was found to be statistically significant, and the control group had the most significant drop-outs.

Important to consider here is that, depending on the setting, a specific type of drop-out did not appear at all. The drop-out from a personal conversation without finalizing a business conversation occurred only in the temporal priority setting and control group, and the corresponding case did not occur in the spatial priority at all ($F=5.801$, $p=0.004$*). Conversely, in the spatial priority setting, I observed the drop-out from the personal conversation to the work conversation without ending the personal conversation, and in the temporal priority setting and the control group, drop-out from personal chat did not appear ($F=8.958$, $p=0.000$*).

3) Check Non-Priority (Personal) Conversation First

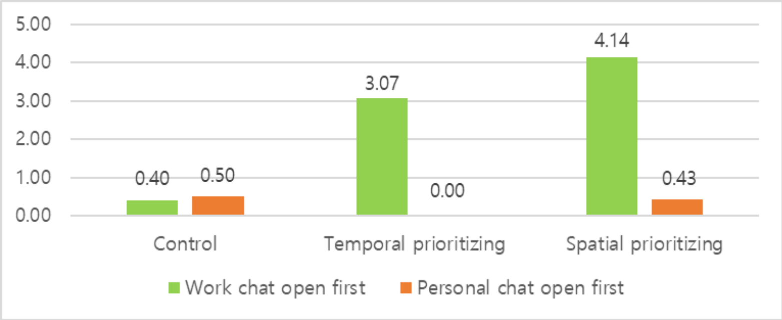


Figure 43 Number of priority checks for personal conversations by group in field study

The final switching behavior is an analysis of which conversation to choose when both a priority and non-priority message arrive. As a result of ANOVA analysis, I found there was a significant difference between the groups. First of all, in the temporal priority setting, there was no case where the personal conversation was selected first (F=3.151, p=0.046*). This result can be attributed to the fact that the rule of the temporal priority setting prevented users from seeing the arrival notification of personal conversations at all if they did not check when a work conversation arrived. As can be seen from the graph above, in the case of selecting a work conversation first, the averages of 3.07 times (SD=3.006) in the temporal priority setting and 4.14 times (SD=3.266) in the spatial priority setting were high, and in the control group, the average was 0.4 times (SD=0.494), which was the lowest (F=26.391, p=0.000*).

5.6.2 Duration Analysis

In this section, as in the Wizard of Oz experimental analysis, I analyze the response time from the message notification to the opening of the chat window, as well as how long the conversation continued in the chat window.

1) Notification Response Duration

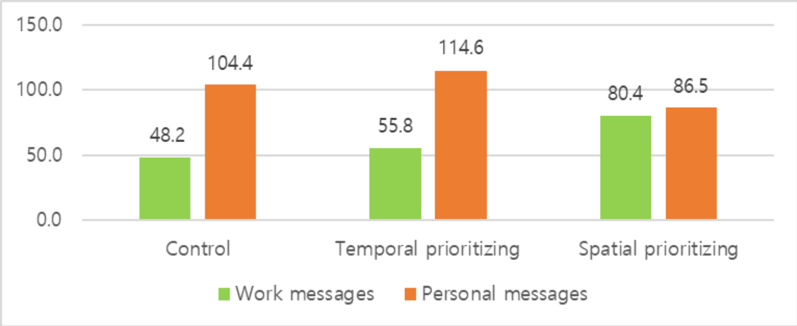


Figure 44 Average notification response time between groups in field study (seconds)

I compared the average response time from the arrival of the message notification to checking the conversation. Because of the analysis, I found there was no significant difference in the average response time for personal conversations by group. However, the response time for work conversation notifications had increased in order of control group (avg=48.2, SD=34.635), temporal priority set (avg=55.8, SD=38.442), and spatial priority set (avg=80.4, SD=59.802), and a significant difference was verified between each group (F=3.377, p=0.038*).

The results of this analysis were opposite to the results of the Wizard of Oz experiment. In the results of the Wizard of Oz experiment, there was no difference between groups in the response time to the work conversation, but there was a difference in this experiment. The response time was the longest when the notification was received in the spatial priority setting. Because it is possible to check the content without having to open the chat window, it can be assumed that it opens late if it is not necessary to respond immediately. In the Wizard of Oz experiment, it was impossible to determine the importance and response of the task because participants was to perform a given task rather than one’s usual task. Therefore, regardless of the setting, the moment the arrival notification was recognized, it was often checked at a similar speed. However, in the case of field studies that have conducted experiments in real situations, the response speed may vary depending on whether it is urgent, a group message with several people, or a task to be responded to.

2) Duration of Conversation

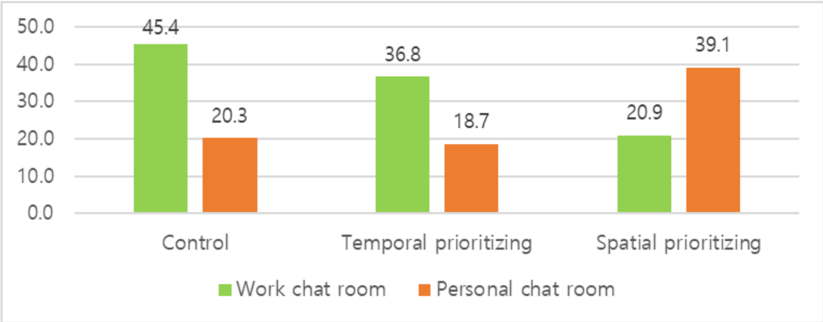


Figure 45 Time spent in chat rooms for each group in field study (seconds)

The average of the time spent starting and ending the conversation was compared. For the two dependent variables, "time spent in a work chat room" and "time spent in a personal chat room," the group-specific differences were found to be significant. In the case of work chat rooms, they stayed the longest in the control group (avg=45.4, SD=30.021), followed by temporal priority setting (avg=36.8, SD=35.440), and, finally, stayed the shortest in the spatial priority setting (avg=20.9, SD=15.692). For the time spent in the private chat room, the shortest time was spent in the temporal priority setting (avg=18.7, SD=13.977), followed by the control group (avg=20.3, SD=16.272), and the longest time in the spatial priority setting (avg=39.1, SD=29.480). The results of this analysis can be interpreted as follows: the most frequent switching occurred in the control group, and relatively more time was spent in identifying and confirming the business conversation.

5.6.3 Characteristics of Each Group

The results of the experiments conducted in real work situations are summarized for each setting as follows.

1) Control Group

When the experiment was conducted in a real work environment rather than a controlled laboratory environment, the control group had the second highest number of switching behaviors but the highest number of deviations during work conversations. Moving on to personal conversations without completing tasks was the most common in this condition, as in Wizard of Oz.

2) Temporal Priority Setting

As in the Wizard of Oz experiment, the overall switching behavior occurred least in the temporal priority setting. In detail, the switching behavior was the least in this setting in both the case of switching from a work conversation to a personal conversation and the case of switching from a personal conversation to a work conversation. Also, work chat drop-out was the lowest. There was no case of selecting a personal message first when both a work and personal message arrival notification came. As a result, it was verified that the temporal priority setting was most suitable in both the Wizard of Oz experiment and the field study performed in real situations to reduce the switching behavior, which is the goal that I ultimately pursued in this study.

3) Spatial Priority Setting

The spatial priority setting showed the greatest difference between the analysis results of the Wizard of Oz experiment and the field study. In the analysis of the field study, the switching behavior was highest in the spatial priority setting. It can be inferred that it was always displayed in the work chat room, it is possible to have a personal conversation and switch quickly when necessary, and because it is possible to make a quick judgment on the work content, it can be seen that a lot of switching occurred when responding according to the context. There was no case of drop-out from the work chat as in the Wizard of Oz experiment.

The biggest reason for the difference in the analysis results of the Wizard of Oz and the field study experiment in the spatial priority setting can be interpreted as work relevance. In the case of the Wizard of Oz experiment, it was difficult for users to judge the weight of the work because it was given a virtual task that was not related to the actual work of each subject in a controlled experimental environment. However, in a field study performed in an actual work environment, the work context can be known and can be dealt with differently. It can be inferred that this part influenced the experimental results.

5.7. Phase 2: Qualitative Findings

Interviews were conducted to investigate the differences between the prioritization strategy and the existing general latest arrival strategy, as well as the perceptions of users about overlapping and switching issues between work and non-work conversations. The interview results were organized into the following three themes.

1) Errors and Anxiety Due to Overlapping and Switching

The study participants routinely experienced commonality in situations in which work conversations and personal conversations were mixed, and they responded that they were uncomfortable. P04 responded, “The mixing itself is annoying,” and P03 answered, “I had no choice but to reply when I was a newbie, even if it was uncomfortable. But later I turned off notifications after I am no longer a newbie.” In addition, some responded that they sent a wrong message or experienced a situation in which the contents were confused while switching between work and personal conversations. Also, to prevent mistakes, there was a response saying that work-related KakaoTalk must be checked once before sending (P03).

"There are many business group chat rooms at work, and there are private rooms, so I tried to separate each chat room by attaching an icon so that it can be recognized. I've seen a lot of cases where the chat room was confusing, sending the wrong message and causing problems." – P01

"KakaoTalk is mixed, so it's hard to check itself." – P05

2) Needs for Control

Participants were skeptical about the external blocking itself. They answered that the effect of blocking itself is small because they will come by phone anyway if there is an urgent matter.

"The ban on personal chats is not convincing. I hate the ban on KakaoTalk. I don't think the company has the authority to monitor personal chat usage anyway." – P04

However, positive responses were observed for autonomous blocking. P02 responded that they routinely block notifications because they have a lot of opportunities to announce or share their screens. However, they responded that they selectively reply by checking the preview function frequently when work and personal conversations have piled up. All participants responded that there were cases where they managed autonomously by blocking notifications themselves or checking them later when necessary. Overall, I observed that the reaction differs depending on who the blocker is and whether the person persuades the need to block, rather than the issue of the effectiveness of the blockade itself.

3) Responses to Message Delivery Strategies

In the qualitative observation, the response to the temporal priority strategy was the most positive. The study participants said, “I definitely felt a difference. The work was clearly focused” (P03), “I was originally going to use it as a way to check the important things first” (P01), and “I think this method will be the most effective to check if a business talk comes in” (P04) replied. On the other hand, some responded that the spatial priority strategy was comfortable because it was always possible to see the contents (P01, P02), other participants felt uncomfortable with being able to see it all the time. P04 replied, “I couldn't see the '1' disappearing, so there were many times I was confused about whether I already read it or nor.” Compared to the time-first strategy and the space-first strategy, one responded that the use of conversations in the general Kakao environment was generally confusing and inconvenient (P03, P05).

5.8. Limitation and Conclusion

This study suggested a strategy to manage messages according to priorities in order to reduce the task switching between work and personal conversations within MIM and to alleviate inconvenience, and the effect was observed in the work situation. In a situation where work and non-work areas are closely mixed within one app, the previously applied blocking-centered strategy had limitations in its application. This is because, if a user blocks the MIM app to block personal conversations, work conversations are also blocked. In addition, even if the notification from the personal chat room is turned off, one problem was that the personal chat notification is also exposed when the MIM is turned on to check the work conversation. In such an environment, this study proposed a temporal priority setting method that manages the message delivery method so that users can check all priority messages before checking non-priority messages, as well as a spatial priority setting method in which priority conversations are fixedly exposed.

As a result, the priority setting method was found to be effective in reducing the degree of switching between work and personal conversations, allowing more focus on work conversations, and improving work performance compared to the existing general message delivery method. In particular, when the strategy was applied in the actual work situation through field study experiments, it was verified that the time priority strategy was more effective than the existing MIM method based on the results of fewer switching, less work deviation, and higher priority conversation selection. In addition, complaints about existing message delivery methods were observed in qualitative observations, whereas positive responses to new prioritization strategies were shown. Therefore, the prioritization strategy proposed in this study has been shown to be effective in preventing excessive switching between tasks and personal conversations appearing in MIM and alleviating distraction problems.

Despite these findings, this study has several limitations. First, it looked at the message delivery method targeting one type of messenger. KakaoTalk, which I selected as the study target in this study, is the most popular app in Korea. However, despite this, various types of messengers were used, and each messenger was different in terms of UI or UX. Accordingly, different messengers may have different effects. Therefore, one limitation is that the results of this study cannot be sufficiently generalized. Therefore, it is necessary to apply the strategy to more diverse messengers through future research.

In this study, I conducted a Wizard of Oz method and a field study to determine whether the priority strategy was effective in a real work environment. However, due to the nature of the MIM app, when using the existing app, it was not possible to collect and analyze all of the messenger’s chat logs due to the security issue of exposing work contents and the privacy issue that private conversations may be disclosed. Also, due to the same problem, it was difficult to recruit users who actually work for the company. In future studies, by addressing these security issues, it is necessary to develop an app for research that implements the priority strategy function without exposing the contents of the conversation, as well as investigate it with a larger number of people.

In addition, I conducted this study assuming a situation in which only MIM is used alone among various functions of a smartphone. However, in actual situations, not only switching between personal conversations and business conversations but also switching between various apps such as YouTube, email, web browser, and phone occurs simultaneously. Therefore, it is necessary to study the utility of the priority strategy in a situation where in-app and between-app switching are complexly occurring through future research.

Additionally, this study is limited in that the priority strategy was observed in a limited environment. In this study, in the Wizard of Oz experiment, one work chat room was prioritized in the work situation, and in the field study, multiple work chat rooms were prioritized in the work situation, and the effect was observed. However, in an actual use environment, there is a possibility of setting priorities for personal chat rooms even during work hours. Through the interviews conducted in this study, I collected the needs of people wanting to check personal conversations first, even if they are at work, depending on family circumstances, and so on. In addition, I did not observe how the prioritization strategy had an effect on either the work or non-work situation after work. Therefore, in future research, it is necessary to make multifaceted observations by considering more diverse variables.

Finally, I conducted an experiment by recruiting knowledge workers who are using smartphone messengers in an actual work environment, but there is a limit to the generalization of the experimental results because usage behaviors and patterns may vary depending on the work characteristics of each occupational group. In follow-up studies, it is necessary to narrow the occupational group and explore it more diversely.

6. Discussion

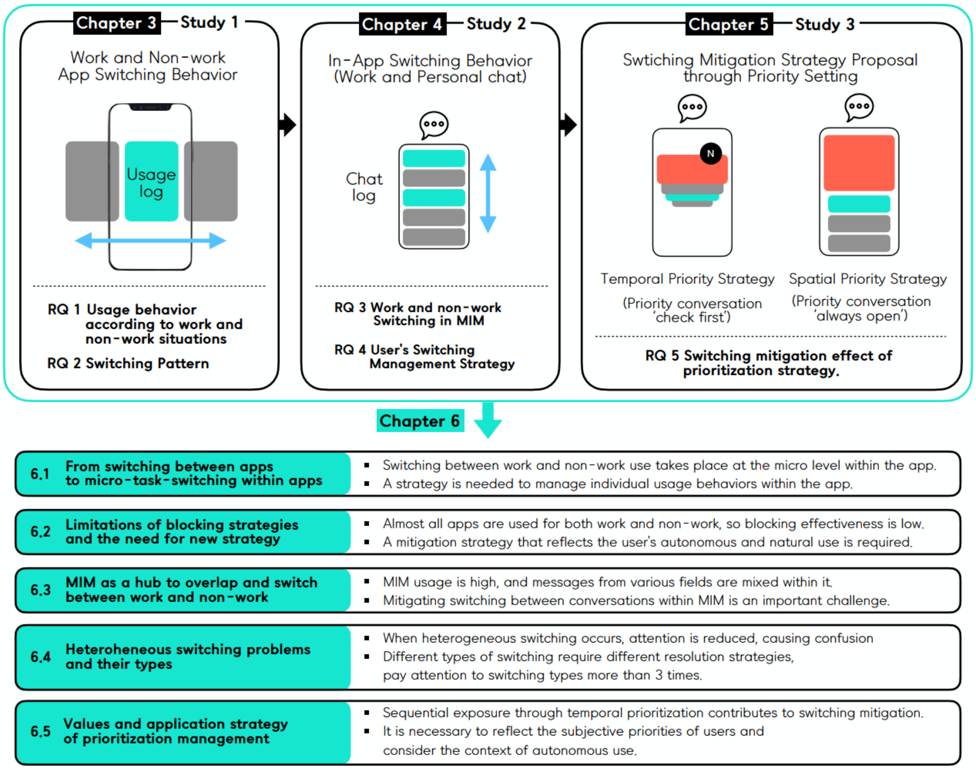


Figure 46 Structure and contents of the discussion

In this paper, I proposed a mitigation strategy to solve the problems caused by overlapping and frequent task switching between work and non-work areas occurring in smartphones and verified the strategy's effectiveness. In this chapter, the implications drawn from the results of the study conducted in three stages are presented. Furthermore, I propose a guideline based on a priority strategy to reduce heterogeneous switching in Mobile Instant Messenger.

6.1. From switching between apps to micro-task-switching within apps

Research on task switching within a smartphone needs to be analyzed at the micro level, which takes place within an app, rather than switching between apps. According to the research results, switching between work and non-work use on smartphones and MIMs is difficult to separate based on specific apps or chat rooms.

For example, a study in Chapter 3 showed that users frequently switched between work and non-work behaviors for as little as a minute or less. In Chapter 4, the switching analysis showed similar results between work conversations and personal conversations within mobile messenger. More specifically, after analyzing heterogeneous switching patterns in Chapters 3 and 4, the most-frequently observed pattern was switching between work and non-work use three or more times. According to the analysis results of Chapter 3, the overlapping of work and non-work use was a behavior that not only appeared in a specific app. Most of the apps were used for work and non-work purposes; likewise, it was widespread, regardless of time of day and day of the week.

According to these results, I argue that the overlap and coexistence between work and non-work currently experienced by users has reached a level of chemical fusion that cannot be easily separated. In other words, the use of different areas of work and non-work is mixing at the level of a single usage log. If the app used for work is clearly defined or if work and non-work use can be separated according to time, users can autonomously classify, separate, and manage work use and non-work use. However, according to the results of Chapters 3 and 4, this overlap has gone beyond the level at which it can be separated by the user's efforts. Existing strategies to solve this problem are mostly based on app-level responses [40], [41], [43], [47]. Therefore, I suggest that researchers could conduct task-switching research from a perspective that narrows down and analyzes behaviors occurring within a single app, rather than app-level switching. This is because changes in the level of analysis and research approaches will help design realistic alternatives and increase the accuracy of user behavior analysis.

6.2. Limitations of blocking strategies and the need for new strategies

As a solution to reduce task switching in smartphones, the effectiveness of separation and blocking strategies is limited. Thus, a method of managing the flow, while maintaining work and non-work use, should be introduced. In this paper, I proposed a temporal priority method that can change the contents to be checked first according to the continuously changing priorities and the situational context.

1) Limitations of Blocking Strategies

The strategy of blocking and separating unnecessary smartphone use is difficult to apply in reality for the following reasons. First, as mentioned in 6.1, switching between work and non-work use occurs frequently, even for short periods of less than 1 minute, and it happens microscopically at the individual usage level within the app beyond the app level. In this case, the effectiveness of the existing blocking strategy at the app level is limited. According to the Chapter 3 findings, it is difficult to distinguish between the time of day for work and personal use from apps. In this situation, blocking a specific app to focus on work or blocking all work-related contacts during personal time after work has a practical limit. In addition, MIM currently provides a blocking function to turn off notifications for a specific chat room or to set a conditional notification. However, once the app is launched, the blocking effect is low because a badge indicating that there is a new message is exposed in all types of chat rooms. Moreover, as MIM is used frequently for work and personal use, it is almost impossible to block the app completely.

In addition, it is difficult to classify smartphone use during work as cyberslacking that interferes with work or as smart-work, which is an advanced form of work. If it is viewed as cyberslacking, the appropriate response is to expand the regulation on smartphone use. However, if it is viewed as part of smart-work, it is appropriate to encourage smartphone use while working. In Chapter 3, a study found that smartphone use for work purposes during work hours was 38.16%, compared to non-work purposes. It is true that smartphone use during work hours has a greater cyberslacking nature. However, it is difficult to conclude if smartphone use is biased toward either side because use for business purposes also accounts for a significant percentage. In this situation, if smartphone use during work is restricted, the parts useful for work will be restricted as well. As a result, the Chapter 3 study found that users actively use smartphones for work and personal purposes while at work, and smartphones are used as an indispensable element in performing work. In other words, considering users' smartphone usage behaviors, it can be said that the existing blocking strategy may have difficulty solving the smartphone regulation debate because smartphones simultaneously inhibit and help people. Therefore, it is necessary to create more detailed smartphone usage policies or manuals that go beyond comprehensive regulations to consider the users' complex usage behaviors.

2) Negative perceptions of users about blocking strategies

The study's qualitative analysis revealed the limitations of the blocking strategy. Interviews conducted in the Chapters 4 and 5 studies indicated that participants were displeased with the policy that bans smartphone use. Despite the inconvenience of being mixed, many participants responded that personal conversations during work and work conversations after work were necessary.

For example, a respondent indicated that messages or calls from family members who live far away or young children should be taken, even if these calls interfere with work. In addition, some responded that they should be reachable at all times after work because urgent and important events may occur in the company. In addition, many participants answered that checking messages for personal purposes while working had a refreshing effect when they were not busy during work.

In addition, one user noted that blocking was wrong beyond the matter of feasibility or utility. In a qualitative observation in Chapter 5, one participant said that blocking personal conversations in order to focus on work was a violation of employees' freedom because they were not born to work. Another participant indicated that a person's time is not clearly divided into office workers and family members. Judging from these results, there is a high probability that the user does not agree to the blocking policy and does not start using it, regardless of the blocking strategy's effectiveness. Therefore, a new type of management strategy beyond blocking needs to be continuously explored.

This study revealed that the blocking policy had low effectiveness through the analysis of actual users' smartphone behavior logs and a perception analysis of blocking and separation policies. In particular, it is less effective in MIM, in which work conversations and personal conversations are closely switched at the micro level. Users want to check their personal messages, even during business hours, and they think they should be able to do so. At the same time, it is necessary to check work messages after work. Therefore, in this paper, I propose a temporal priority method that does not completely block work or non-work messages. Rather, it shows the contents to be checked first according to priority and then allows users to check non-priority messages freely.

6.3. MIM as a hub to overlap and switch between work and non-work

Among the numerous smartphone apps, MIM is where switching between work and non-work use takes place the most. Therefore, mitigating switching within the MIM is important. In the Chapters 3 and 4 study, MIM apps showed the highest usage rates for work and non-work-related usage. In addition, people had personal conversations while doing business with MIM. According to the cross-analysis in Chapter 3, the cluster composed of MIM accounted for the largest proportion in work-related sessions, but simultaneously, non-work-related sessions accounted for 40.7% (NWatW) and 40.60% (NWatNW), respectively, showing a high usage rate. As a result, work and non-work actions occurred with high probability in the MIM. These results show that the mixture between the work area and the non-work area occurring within the smartphone is best revealed in MIM. In addition, switching and distraction problems between the work and non-work areas are intensified in MIM. In particular, it is difficult for users to check messages by dividing them into work and non-work purposes because MIM sorts messages in order of arrival. Therefore, there are many cases where the user switches to a personal conversation while checking the work message, or vice versa. Therefore, it is important to improve the message management strategy of MIM, where work and non-work actions overlap at a high rate. Based on these results, this study focused on MIM's priority strategy described in Chapter 5 and observed the effect.

6.4. Heterogeneous switching problems and their types

In task-switching studies, it is important to consider the context and purpose of the task. As heterogeneous switching between tasks with different purposes causes more problems than homogeneous switching between tasks with the same purpose do, I propose focusing on measures to reduce heterogeneous switching. In addition, it is necessary to analyze the types and characteristics of heterogeneous switching in more detail and to reflect them in strategy design.

In this study, I analyzed the patterns and effects of switching behavior in smartphones. In Chapters 3, 4, and 5, switching behaviors were classified into homogeneous switching with the same purpose and heterogeneous switching with different contexts and purposes, and characteristics were arranged according to the switching patterns between them. Among them, the most important was the results of the heterogeneous switching analysis. Heterogeneous switching was generally found to have a negative effect. According to the study results in Chapter 4, in the case of heterogeneous switching, there were many middle-conversation breaks, a longer session, and more conversation. In other words, compared to homogeneous switching, heterogeneous switching showed a more-frequent tendency to switch chat rooms in different contexts and to lengthen the session. In the qualitative observation, respondents indicated that, when work and personal conversations were mixed, the conversation contents were confused, and concentration was disturbed.

In addition, the problem of heterogeneous switching was observed in the Chapter 5 study. When work was performed in the existing delivery setting, the drop-out rate during high-priority conversations was higher than the priority strategy method proposed in this study, and the rate of checking non-priority conversations before priority conversations was higher. In addition, the time spent in non-priority chat rooms was longer, and work performance was lower. The interview results support this finding. A participant said she usually had a personal conversation in the middle of work, and when she returned to work, she forgot how far she had gone or had lost her concentration. Therefore, she would mark her work progress before the conversation. These results found that, especially in the case of heterogeneous switching, it was difficult to retain the memory of the previous behavior’s contents and goals, and it took a long time to catch up with the original context after returning. These research results coincided with the existing task-switching theory that cognitive costs are higher because a new task-set must be configured when switching to a task in a completely different context [34].

Looking more specifically at heterogeneous switching, patterns with different characteristics are identified in detail. I suggest that different response strategies need to be devised for each of these patterns. Looking at the analysis results of Chapters 3 and 4, there are types that are likely to be evaluated negatively among heterogeneous switching types. In both studies, the highest occurrence of the switching type was switching three or more times between work area and personal area in one smartphone use or in one conversation. This type of switching pattern represents a state in which people are constantly switching between work and non-work use, so that they cannot focus on either, with high cognitive costs. This type of switching can be negatively evaluated in work and non-work aspects. In addition, switching to a non-work area during work is a deviation during work and can be viewed as negative switching. On the other hand, for the switching type that starts with work use during work, switches to non-work use for a while, and then returns to work, it can be considered an acceptable switching type, in that the employee returned to work even though they did something else in the middle. Therefore, rather than viewing all task switching as a regulation target, it is necessary to establish an appropriate response strategy for each type by considering the characteristics of each detailed usage type among heterogeneous switching.

6.5. Values and application strategies of prioritization switching management methods

In Chapter 5, I proposed and observed the effect of allowing users to prioritize conversations as a strategy for mitigating the switching between work conversations and personal conversations. Priority strategies are designed to propose realistic alternatives that do not infringe on user autonomy by borrowing and improving the characteristics of existing management strategies. As discussed in Chapter 2.3, unlike the existing task insertion strategy that imposed low-related tasks, such as button entry to obtain smartphone usage permission, the temporal priority strategy proposed in this study set the task-related behavior (check work messages first) as an inserted task in MIM. By doing so, it was intended to reduce work deviation and to help reduce switching. In addition, non-priority message notifications are delayed until priority messages are checked, so that non-priority messages are naturally delayed according to the flow of the user's work. In other words, in a situation where there is no busy work, delay does not occur because delay is not necessary. On the other hand, in a situation where many priority messages arrive, the non-priority message is delayed until it is confirmed first. In addition, this study proposes a way in which switching can be mitigated according to the natural context of smartphone use based on user autonomy by not completely blocking either use. The existing strategy managed the smartphone use for each app unit, failing to manage the use that takes place within one app. However, the priority strategy proposed in this study can mitigate switching within a single app. Therefore, these strategies have actually been shown to reduce switching between task conversations and personal conversations, continue priority conversations longer, and consequently effect task performance positively.

Based on the Chapter 5 results, I will summarize some suggestions for reflecting the priority strategy and explain the characteristics and specific methods of the strategy proposed in this study.

As much as possible, it should not interfere with the user's autonomous use context. The strategy should reflect the needs of users who do not want messages that are missed or inaccessible. In the Chapters 4 and 5 studies, users were convinced to check what they did not need to check immediately, but they showed a sense of rejection and skepticism about blocking the messages. In addition, they responded that it was necessary to check important personal messages during work, and they did not consider checking personal messages a hindrance to their work when they were not busy. In addition, users responded that they needed to check messages that were out of context, such as work messages after work, although they were uncomfortable doing so. Based on the users' needs, I proposed a strategy that allows access to all messages, rather than blocking incoming messages or access. I propose a way to mitigate switching by readjusting exposure sequences without compromising the natural usage context of a mix of work and personal conversations and by allowing access to all conversations if there are no new messages in the priority chat room.

It should reflect the priorities that users think. The criteria for priority are different for each user, which may vary depending on the situation and context. Even when working, there are special family issues, such as illness and moving, so it may be necessary to check personal messages first. Likewise, even after work, there may be situations in which important messages need to be checked first, depending on the work's progress. Therefore, in Chapter 5, I propose a way to allow users to set their own preferences based on their own priorities, rather than establishing automated filtering rules through the system, considering these usage contexts and needs.

Sequential exposure is more effective in mitigating switching than static exposure is. The way priority chat rooms are always fixed and displayed is eyecatching in the actual usage environment, making it difficult for users to focus on their work (Chapter 5), which increases messenger use, making them more likely to check personal conversations. In comparison, the time-priority strategy to adjust the messages' confirmation order required that the preferential conversation be checked first, leading the user to focus on the conversation content before checking the non-priority conversation. This eased switching in the qualitative and quantitative observations. Therefore, I propose applying a strategy that exposes priority conversations sequentially, rather than fixed and exposed to specific areas, when designing future systems.

7. Conclusion

I suggest a strategy to alleviate the distraction problem that occurs due to frequent switching between work and non-work areas that users experience on smartphones. I first conducted an empirical study on the usage behaviors and switching types of work and non-work apps on smartphones. The data collected from these first-stage studies (Chapter 3) revealed that switching between work and non-work use occurs most frequently in MIM, and as the second step (Chapter 4), switching patterns between work and personal conversations and user bypass strategies were collected in MIM. Also, as the final step in the study (Chapter 5), I proposed and evaluated a method of delivering messages according to temporal and spatial priorities as a strategy to reduce excessive switching behavior between work and personal conversations in MIM. The last chapter summarizes the contribution of these studies and describes future research tasks.

7.1. Summary of Contributions

This study is meaningful in that it empirically explored the overlapping and switching problems between the work and personal areas users experience in the use of smartphones and mobile messengers and suggests practical solutions for alleviating the problem. Specifically, the study can be described in the following three aspects.

Empirical research contributions: In this study, a more realistic switching type between work and non-work was derived by performing session classification analysis by collecting the logs that users actually used in work and non-work situations on a large scale. In addition, through qualitative research such as diary analysis and interviews, users' responses and detour strategies were collected and were analyzed together with the context of work and non-work switching behavior and distraction problems. Through this, I have drawn a result that can examine the newly emerging work and non-work mix and the distraction problem caused by excessive switching between them from multiple perspectives, which is expected to contribute to designing other studies related to this problem in the future.

Strategic implications for the user experience: Based on the data collected through quantitative and qualitative analysis, this study deeply identified problems related task switching in mobile messaging apps, pointed out the limitations of existing countermeasures, and proposed a new type of response strategy to mitigate them. Specifically, unlike the existing task insertion strategy, which mainly assigns tasks with low relevance to the work context, such as button input and text input, in the case of the strategy presented in this study, a work conversation is presented as an actual task so that it can be checked first. This strategy meaningfully reduces deviations in the context of work and prioritizes checking the contents of priority conversations before non-priority conversations. In addition, unlike the existing strategy of delaying notification by using separate rules, the method proposed in this study is more closely related to work by allowing the delay to be determined fluidly according to the time the conversation-checking task occurs. It is also meaningful that it proposes a method that does not reduce a user's autonomy by blocking or restricting the use of the app and that does not distort a user’s natural use context by adjusting the priority of message checking. Finally, the switching mitigation strategy proposed in this study is meaningful in that unlike the existing app unit management strategy, it can manage the switching behavior that appears within one app. These results are expected to provide new clues to overcome the limitations of traditional methods when trying to manage messages that are actually mixed with each other in mobile messaging apps in the future.

Theoretical contribution: This study revealed that mixing and overlapping between different conversational areas takes place during smartphone use by analyzing switching behavior in the context of work and non-work usage beyond the existing task-switching level and deriving its meaning. These results are expected to provide new domain knowledge to smartphone log analysis or task switching research flows.

7.2. Future Directions

Smartphones are increasingly being used in more areas of life. As time passes, fewer tasks can be completed without the services provided by smartphones and apps. Today’s smartphones are being used as an inevitable tool through all events in life, from birth to death, and this change is irreversible. As this phenomenon intensifies, numerous tasks with different characteristics will overlap in the single device called a smartphone, mixing between different areas will occur more often. As a result, exploring the mix between various areas of smartphones and the resulting distraction problems and studying strategies to alleviate them will become of greater social importance in the future.

Against this background, I would like to describe the future research direction based on the limitations of each detailed study I conducted. First, I conducted a study on the type of switching between work and non-work use in smartphones (Chapter 3), and I conducted an analysis based on the usage log. Because it is impossible to grasp the context of the app's use with simple log analysis, I collected information on whether the reason for using the app is for work or non-work purposes by assessing users' self-recording using the diary method. Through this, it was possible to explore the amount of use for a specific purpose and situation, as well as identify the switching pattern. However, there is a limit to the inaccuracy due to memory distortion in the self-recording method. Therefore, in future studies, it is necessary to apply an automated method that can collect the context of the usage log or a recording method that can compensate for the loss of information due to forgetting. In addition, this study has a limitation in that the period of collecting data for each subject is relatively short. Therefore, in future studies, it is necessary to increase the reliability of the results through longer term data collection.

In the second study (Chapter 4) on the type of switching between work and personal conversations within MIM, there is a limitation in that it was conducted using only a part of the chat room, not all chat rooms used by users. Through existing social surveys and pilot studies, I found that an average of six group chat rooms are mainly used in MIM by users, and based on this, six were selected as research subjects. However, future studies need to target all chat rooms in which each user is participating, given that there is a possibility that conversations will take place in other chat rooms and that such conversations can affect the switching patterns between existing work and personal conversations. In addition, 10 people participated in this study, so the number of participants is small, which is difficult to generalize. To compensate for this, I collected and analyzed large-scale conversation records for 3 months for each participant. However, because limitations still exist due to the small number of subjects, future studies need to collect and supplement the MIM conversation history of more subjects.

Finally, the study of Chapter 5, which proposed and evaluated a message management strategy of a priority setting method, is limited in that it conducted an evaluation assessment on only one type of messenger. Therefore, in future studies, data should be collected in various messenger environments to enable more multifaceted evaluation and understanding. In addition, I utilized in this study the Wizard of Oz method, which directly performs the role of messenger delivery, to demonstrate and evaluate delivery strategies that do not exist in real situations, and I conducted a second experiment through field studies. However, due to security and privacy issues, I did not conduct the experiment on many subjects, and there is a limit to collecting only daily usage logs. Therefore, in future studies, it is necessary to create a prototype of an app that actually works and conduct a long-term survey of more users so as to assess how the prioritization strategy works in the real work environment.

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국문 초록

오늘날 스마트폰은 우리 삶의 거의 모든 영역에서 필수불가결한 도구로 사용되고 있다. 영상 및 음악 감상이나 게임 등 여가활동뿐만 아니라 이메일 전송과 문서 작성 및 보고에 이르기까지 업무 영역에서도 보편적이고 일반적으로 스마트폰이 활발히 이용되고 있다. 많은 현대인들은 스마트폰 덕분에 언제 어디서든 여가를 즐기거나 업무를 수행할 수 있게 되었다. 그러나, 하나의 단일한 디바이스 내에서 서로 다른 영역이 빈번히 중첩되어 사용되면서 사용자들은 과도한 과업 전환과 집중 방해 (distraction)을 경험하고 있다. 이에 따라 업무 중에 개인 목적으로 스마트폰을 사용해서 업무에 지장을 주는 cyberslacking 문제나 퇴근 후에 메신저로 업무 지시를 받는 일상 침해 문제가 최근 사회적으로 대두되어왔다. 이러한 문제에 대응하기 위한 기존의 전략은 주로 각 상황에 맞지 않는 사용을 분리하고 이를 차단하는 형태로 이루어져 왔다. 하지만, 동일한 도구 혹은 어플리케이션(앱)이 업무 목적과 개인 목적 모두에 동시 사용되고 있는 현재의 상황에서 차단은 유효한 해결방안이 되기 어렵다. 특히, 모바일 메신저(Mobile Instant Messenger, MIM)과 같이 업무와 개인 사용이 동시에 벌어지고 있는 앱 같은 경우 개인 사용을 막기 위해 앱을 차단하면 업무 사용까지 함께 막히기 때문에 차단은 현실적으로 적용하기 어려운 방안이다. 따라서, 이러한 맥락을 전제한 새로운 전략의 모색이 필요한 상황이다. 이러한 배경에서 이 연구는 스마트폰 내 업무와 개인 사용 간 빈번한 전환과 이로 인해 발생하는 집중 방해 문제를 완화하기 위한 새로운 전략을 제안하는 것을 목표로 한다.

먼저, 새로운 전략을 모색하기 위한 첫 단계로서 현상에 대해 구체적이고 실증적인 이해를 하고자 하였다. 이를 위해 실제 상황에서 기록된 사용자들의 앱 사용 로그(log)를 수집하여 업무 및 개인 목적의 사용이 각각 어떤 앱에서 얼마나 벌어지는지 살펴보았다. 또한, 업무

사용과 개인 사용 간 전환 빈도와 유형에 대한 탐구를 통해서 구체적인 사용 패턴을 관찰했다. 18명의 참여자로부터 45,398 건의 로그 이벤트를 수집해 분석한 결과, 모든 종류의 앱에서 업무와 개인 사용이 혼재되어 나타났으며 사용 패턴에서도 업무와 개인 사용 간 빈번한 전환이 다수 관찰되었다. 결과적으로, 이 연구를 통해 스마트폰 내 업무와 개인 사용이 단순한 물리적 결합 수준이 아니라 화학적 융합에 가깝게 뒤섞여 있음을 파악할 수 있었고, 특히 MIM 내에서 그 정도가 심화되어 있다는 것을 밝혔다.

두 번째 단계에서는 첫 단계의 연구 결과를 심화하여 MIM 내의 업무와 개인 사용 간 전환 패턴에 대한 연구를 수행했다. 이를 위해 두 단계에 걸쳐 각각 1달 그리고 3달 동안 벌어진 실제 사용자들의 대화 기록을 수집하고 업무 대화와 개인 대화 간 전환 유형을 분석했다. 더 구체적인 파악을 위해 발신 메시지의 비율이나 대화 참여도 그리고 주고받은 정도 등의 대화 특성과 전환 행태가 어떤 상관 관계를 갖는가에 대해서도 탐구하였다. 추가적으로, 인터뷰를 통해 이러한 중첩 문제를 해결하기 위한 사용자들의 우회 전략을 수집했다. 10명의 참여자로부터 각 103,344 개, 198,505개의 대화 로그를 수집해 분석한 결과, 사용자가 한 번 MIM을 사용할 때 업무와 개인 대화 사이를 3회 이상 전환하며 사용하는 유형이 가장 빈번하게 벌어지는 것으로 나타났다. 또한, 업무와 개인 대화 중 어떤 대화로 시작했는지가 전체 대화 비중에 큰 영향을 준다는 것을 파악했다. 정성적 관찰 결과, 사용자들은 MIM내 업무와 개인 대화가 빈번하게 전환되는 상황을 불편해하고 있었으며, 메시지를 미뤄뒀다가 한 번에 확인하는 등 우회 전략을 사용하고 있었다. 하지만, 이러한 자율 관리에 실패를 경험하고 있었다. 이에 따라, MIM내 업무 및 개인 대화 간 전환 관리 전략이 필요하다는 것을 밝혔다.

앞선 첫 번째 그리고 두 번째 단계의 연구 결과를 토대로 마지막 단계로서 MIM내 업무 및 개인 대화 간 전환을 줄일 수 있는 관리

방안을 제안하고 그 효과에 대해 탐구했다. 이미 개인 대화와 업무 대화가 빈번하게 전환되며 화학적 융합 수준으로 중첩되어 있는 상황에서 기존의 단순한 차단 전략은 한계가 있기 때문에, 개인 대화와 업무 대화 간 전환을 줄이기 위한 방법으로 우선 순위를 설정하는 전략을 제안했다. 이 우선순위 설정 전략은 기존의 email과 MIM에서 사용되고 있는 메시지 관리 전략과 정보 과잉 관리를 위한 방법에 대한 기존 연구를 차용하고, 한계를 보완하는 방식으로 설계했다. 구체적으로, 우선 설정 대화를 먼저 확인해야 비우선 대화를 확인할 수 있도록 시간적 우선 순위를 설정하는 방식과 업무 대화가 언제나 고정되어 먼저 보이도록 하는 공간적 우선 순위 설정 방식을 고안했다. 그리고 Wizard of Oz 실험을 수행하여 참여자가 간단한 업무를 하면서 각 메시지 전달 및 관리 방식을 경험하도록 하고, 이에 따른 반응과 업무 수행도를 관찰했다. 또한, Wizard of Oz 실험의 한계를 보완하기 위해 실제 업무 상황에서도 관찰 실험을 추가로 수행했다. 그 결과 두 우선순위 설정 방식 모두에서 개인 대화와 업무 대화 간 전환을 줄이는 효과가 나타났고, 업무 수행 정도도 일반 전달 방식에 비해 높게 나타났다. 특히, 시간적 우선 순위 방식이 실제 업무 상황에서도 우선 대화와 비우선 대화 간의 전환을 완화하는 효과가 있는 것으로 나타났다. 또한, 정성적 평가 결과에서도 우선순위를 설정했을 때 업무 집중도가 높고 업무 수행의 만족감이 더 높은 것으로 나타났다.

이 연구는 실제 상황에서 기록된 사용 로그 데이터 분석을 통해 스마트폰 및 MIM 내에서 업무 사용과 개인 사용이 분리 불가능한 수준으로 중첩되어 벌어지고 있으며, 그 사이에 빈번한 전환이 나타나고 있음을 밝혔다. 특히 모바일 메신저 등 동일한 앱 내에서 많은 전환이 벌어지고 있어서 기존의 앱 차단 중심 전략이 적용 불가능하다는 것을 알리고 새로운 대응이 필요하다는 것을 밝혔다. 이러한 결과는 향후 이 문제에 대한 기술적, 학술적, 사회적 대안을 마련할 수 있는 근거로서 활용될 수 있다. 또한, 이 연구는 사용자가 이러한 상황에 불편을 겪고

있으나 자율 관리가 어렵다는 점을 알리고 이에 적용될 수 있는 새로운 대안으로 우선순위 기반의 메시지 관리 전략을 제안하고 그 효과를 밝혔다. 이 전략은 기존의 차단 중심 전략을 넘어 사용자가 경험하고 있는 잦은 전환으로 인한 불편을 해소하는 데 기여하는 새로운 대응의 단초를 실질적으로 제시했다는 의의가 있다.