

# Industrial product innovative design of toilet sensor timer

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## Abstract

This study came up with an innovative product design for toilet safety timer, which can be installed in public lavatories or toilets at home. When an elderly person is in a toilet for a period of time longer than the time set in the device, a warning will be sent to the outside. The unique feature is the safety device of the sensor timer with the innovative structure containing an infrared sensor, a CPU, a timer, and a warning device. Users can set up the time on the timer. In case of an emergency such as users falling by accident or being in a coma, a warning will be sent out in time to get help to prevent tragedy from happening.

*Keywords:* Toilet Safety, Timer, Industrial Product

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## 1 Introduction

Toilets are essential in people's daily lives. With the advancement of time, life quality of humans has been improving. Therefore, the needs of the elderly in toilets have gradually been considered. For example, there are stools with armrests to help users to get up [1]. Moreover, there are alarms in some toilets for calling for help in case of an accident. Although designers have already made some improvements based on users' needs to make toilet environments better, according to newspapers and news reports, there have been still a lot elderly people stumbling or falling unconscious due to infirmity or illness and not found in time, leading to tragedies, which could have been avoided.

However, privacy of public lavatories and toilets at home is very important in order to maintain users' dignity. However, when elderly users use toilets, they are isolated after locking the doors. If they are tripped by accident or fall unconscious and cannot trigger the alarms, they may not be rescued in time. Furthermore, their families outside have no idea what happens inside the toilets and may worry about the elderly users having some accidents inside and not being able to be rescued in time without warning signals. These are all issues related to toilet environments, which need to be improved. Therefore, this study thought about how to develop an innovative structure, which can send warning to the outside of toilets to ensure users' safety while being inside.

## 2 Literature Review

Since 1993, the Taiwanese society has become an aging society defined to the UN. As age increases, problems caused by ageing would come one after another, and thus auxiliary tools would play an important role in the lives

of the elderly. People go to toilets every day. However, sitting on stools is a burden, which the elderly have to face every day. Therefore, Huang considered heights of stools and users' habits and simulated people's movements of standing up from sitting positions, for the analysis and development of an auxiliary mechanism. With the features of the slider crank mechanism, Huang designed an auxiliary device to help users stand up from toilet stools using the changes of sliding blocks and rods. According to the results of the study, if the height of the stool is increased by 81mm with the angle of 30°, the elderly can get up a lot more easily [9].

Some scholar improved toilet stools for elderly female people, in hopes of solving their problems with movements limited due to their knee osteoarthritis [2]. Cheng considered that degeneration of lower limb functions might make daily activities difficult and even increase the possibility of stumbling and falling due to their moving difficulties. Thus, Cheng objectively assessed the abilities of sitting and squatting of the elderly to learn more about their risks of tripping. After the investigation, it was found that the explosive force from the lower limbs of the elderly is rather weak. Their lower limb movements are slow but stable. The result is that when they perform a functional active, they do it slowly with small strength. However, to prevent one from tripping and falling, his lower limbs must be able to make efficient and quick reactions in a very short time. Therefore, those who may trip and fall are those with small strength and those who need a longer time to develop strength in lower limbs. The study found that explosive force trainings are good for the elderly to reduce their chances of tripping and falling [3]. Furthermore, the elderly with back pains may have problems with dynamic balance while walking and overstriding an obstacle [5].

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Lee discussed the public lavatories in the train stations in Taiwan and found that they needed to be improved for the lack of sitting stools, unqualified equipment or barrier-free space, and insufficient software or greening [4]. In addition, Chen used a research population of public lavatories, which were categorized into railway station lavatories, bus station lavatories, pit stop lavatories, theatre lavatories, and university lavatories, and high school lavatories. A random sample of 662 lavatories from 114 places was used for investigation. The result shows that lavatories with toilets for the disabled still had the defect of having only squatting toilets. In addition, the commodity shelves, auto hand dryers, alarms, and broadcasting equipment were all not ideal. Chen suggested that there toilet papers should be provided and there should be armrests for the elderly and the weak [8, 11].

### 3 Innovative product design

#### 3.1 PRODUCT DEVELOPMENT

The procedure of product development includes 6 phases: (1) planning: performing technology development and market target evaluation through the opportunities confirmed by the enterprise; (2) concept development: confirming the demands of the target market; (3) system-level design: defining product structure and dividing the product into systems and components; (4) detail design: confirming the geometric shapes, materials, and common differences of all the parts of the products; (5) testing and refinement: making several samples for testing, making improvements, and assessments; and (6) production ramp-up: training related staffs to solve the unsolved problems during the manufacturing process.

Product development is a cross-field activity. Almost all departments of an enterprise must participate in the enterprise's product development and cooperate. The key departments are marketing department, design department, and manufacturing department. An enterprise's marketing department is the bridge of interactions between the enterprise and customers. It helps to confirm product opportunities, define marketing segmentation, and confirm customers' demands. The design department is in charge of defining physical forms of products to achieve the highest customer satisfaction. The main job of the manufacturing department is to operate or coordinate production systems to manufacture products [6].

Product development is an enterprise's activity beginning with finding market opportunities, manufacturing, marketing, and ending with delivering products to customers. The indicators of whether product development is successful include: (1) product quality: reflecting whether a product satisfies customers' demands and whether the product is reliable; (2) product cost: cost of manufacturing a product; (3) development time: how much time the development team needs to complete the

development project; (4) development cost: the cost from the development procedure; and (5) development capability: whether the enterprise can develop a product in a more economic and efficient way [7].

#### 3.2 MANUFACTURING

A manufacturing activity is a composition of inputs, transformation, and outputs. A manufacturing process includes all the activities of developing and manufacturing new products or providing services to customers. When developing and designing a new product, encountering difficulties is very common. If there is a problem with a product, the reasons behind it must be analysed with the person in charge and supporting staffs assigned, to come up with a solution and date of completion of improvements, in order to control the schedule and results. Before mass production of a product, units related to R&D, design, and engineering all must be very strict with reviewing and quality control.

The design quality evaluations for a product before mass production include: (1) Engineering Verification Test (EVT): evaluating the appearance, mechanical structure functions, part specifications, and applicability of the product; (2) Design Verification Test (DVT): evaluating the electric property specifications, mechanical functions, and environment reliability, and marginal test; (3) Manufacturing Verification Test (MVT): performing small-quantity pre-production to evaluate the suitability of product functions and production ability; and (4) Reliability Test: performing tests impacting or dropping the product, temperature cycling test, high/low temperature cycling test, and life test. In case of a defect or product failure during the evaluation, the Quality Department must notify the Engineering Department to analyse the reasons of the defect and provide a solution. After corresponding improvements are made, these tests must be performed again to confirm that the issue has been resolved [10].

### 4 Design results

The technical feature of this innovative product in solving the issue is to install the infrared sensor in a toilet stall and connected with a timer and a warning device which are placed near the door on the outside through the CPU. The CPU is connected to the infrared sensor and the timer. When the CPU receives a signal from the infrared sensor when a user goes into the toilet, the timer starts. Moreover, the warning device is connected to the timer. Once the time is up, the alarm is triggered. The alarm can be a warning flashing light or a buzzer. The connections between the timer, the warning device, the infrared sensor, and the CPU can be wireless or wired.

The procedure of how this product works is as follows: After the infrared sensor detects a user's body, it sends a signal to the CPU. Then the CPU transforms the signal from the infrared sensor and sends the transformed signal

to the timer. Moreover, the timer starts. If the user takes more time than the default time set in the timer, the timer sends a signal back to the CPU. The CPU transforms the signal from the timer and sends the transformed signal to the warning device. The warning device is activated. It rings or flashes to warn others. This product is composed of an infrared sensor, a CPU, a timer, and a warning device. It can send out a warning when a toilet user trips and falls by accident or falls into a coma, so that other people can rescue the user immediately and handle the situation. Figure 1 is a flow chart, which shows how signals travel between devices. Figure 2 & 3 shows the case that the user does spend more time than the set time so the safety device is not triggered by the timer and the warning device does not send out any warning. Figure 4 & 5 shows the case that the user spends more time than the set time so the safety device is triggered by the timer and the warning device sends out a warning. The utility model patent for this innovative product has been approved by the TIPO, with the patent number of M 445232 and the patent duration of 2013/1/11-2022/8/27.

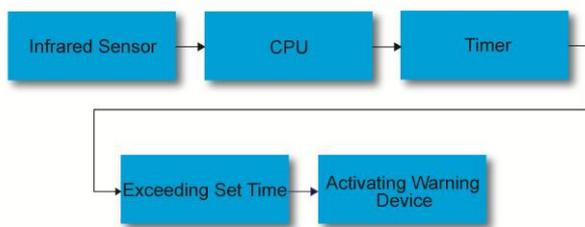


FIGURE 1 Flow Chart of How Signals Travel Between Devices

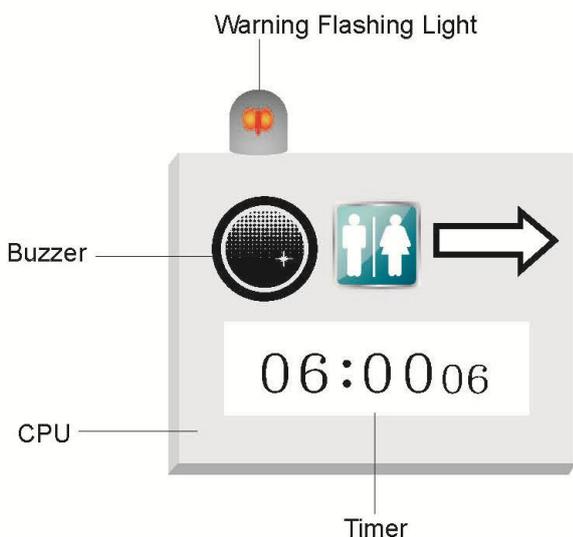


FIGURE 2 Normal Situation

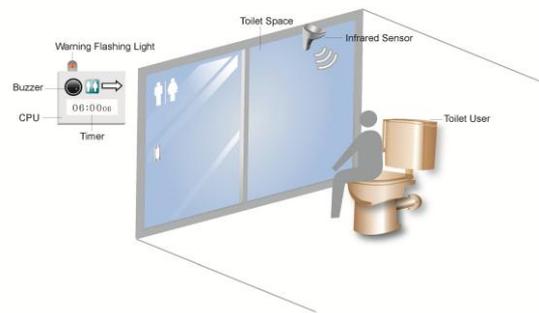


FIGURE 3 Normal Situation

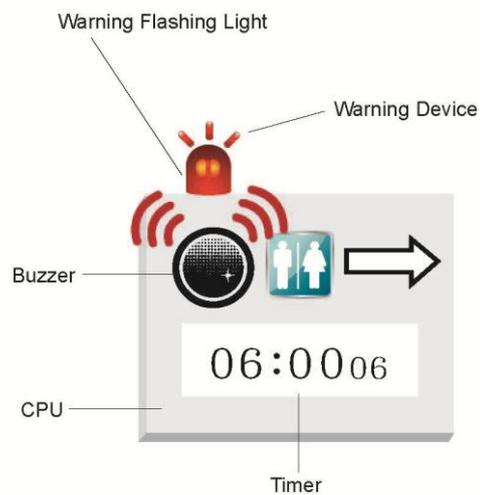


FIGURE 4 Emergency Situation

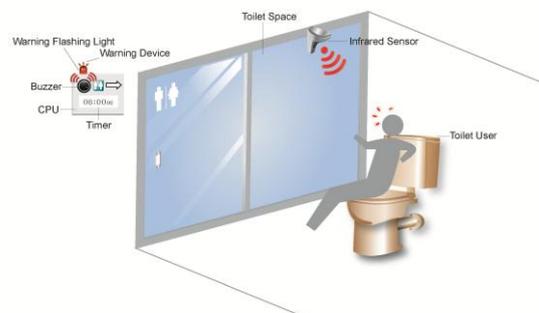


FIGURE 5 Emergency Situation

## 5 Conclusions

The first consideration of developing this innovative product, a toilet sensor time safety device, is that the elderly may trip and fall or fall into a coma due to illness or accident. In addition, the purpose is to provide the elderly a safer toilet environment.

### 5.1 DISCUSSIONS

- 1) *Designing with care for lives:* The innovative product of this study was developed based on the care for lives. After having considered users' needs, necessary safety designs were proposed to build a safe toilet

environment, show the care and respect for human lives.

- 2) *Confirming customers' demands*: This study observed and recorded the toilet behaviours of the elderly, found users' needs, made plans of important layers, and then proposed a strategy, which can meet customers' demands regarding toilets.
- 3) *Choosing target market*: In the face of the aging society, this study chose the needs of the elderly as the target market orientation to design an innovative product, in hopes of helping the elderly to use toilets more safely.
- 4) *Safe toilet environment*: It is hoped that, through the innovative design of this product, a safer toilet environment can be created, indirectly releasing caretakers' mental pressure.

## 5.2 SUGGESTIONS

- 1) *Innovative product design*: It is essential to carefully observe various people, events, and objects in daily lives and keep records. After proposing a solution or a strategy, it must be implemented for the purpose of accumulating new knowledge of technology and it

can be used as a reference for manufacturing and practical applications.

- 2) *Patent application*: When a good idea is generated, it is suggested to file a patent application in time to protect the patent right later when the product is developed and manufactured.
- 3) *International invention competition*: In the global innovative invention competition, Taiwan is only second to the US in competition results, showing the Taiwanese people's deep interest in innovative design and their potential. It is suggested to, after the patent application is approved, actively participate in international invention competitions to get more opportunities to promote the product and increase the possibility of mass production.
- 4) *Technology transfer*: During the model-testing phase of the innovative product, it is suggested to participate in more exhibitions for industrial exchanges to strive for more opportunities of technology transfer, in order to implement the good idea of the innovative product in daily lives, making people's lives safer, more convenient, and more comfortable.

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