

Independent Bathing for Older Adults: The Conceptualization of the iMagic-BOX Portable Walk-In Bathtub

Chew Kien Ming^{1(✉)} and Jeffery Yeow Teh Thiry²

¹ Inventor, iMagic-BOX, Kuala Lumpur, Malaysia
stefan@imagic-box.com

² Researcher, iMagic-BOX, Kuala Lumpur, Malaysia
jeffery@imagic-box.com

Abstract. The rising issue of world population ageing has brought about increasing concern for the well-being and healthcare needs of older adults. With the unfortunate current state of professional elderly healthcare, the duty of caring for their needs often falls to family members. With current trends pointing towards a shift to a more independent lifestyle for older adults, it becomes increasingly important that technologies are developed to assist their daily living. This paper describes issues involving the everyday task of bathing in tandem with the advent of the walk-in bathtub concept. Unfortunately, due to severe design flaws, conventional market offerings of walk-in bathtubs tend to cause more harm than good, prompting a need for an overhaul of the design concept. Hence, this paper outlines the conceptualization and design methodology of the iMagic-BOX portable walk-in bathtub, a series of mobile, walk-in bathing and shower units designed to assist older adults to be able to independently and comfortably bathe on their own. The goal of this paper is to showcase the individual design elements of these specialized walk-in bathtub units in hopes of inspiring other inventors to appreciate the role of gerontechnology in improving the lives of older adults worldwide.

Keywords: Gerontechnology · Invention · Healthcare · Walk-in bathtub

1 Introduction

Amongst the various demographic complications seen in recent years, the significant demographic shift in population ageing stands in prominence. Various factors, such as the rise in life expectancy rates at birth have increased the proportion of older adults aged 60 years or over to significantly higher levels [10]; this number was projected to more than double itself from projected numbers of 901 million in 2015, to 2.1 billion in 2050. In other words, if this projection becomes a reality, the world will have more than 830 million persons aged 80 years or over by the end of the 21st century. The United Nations also reported that 40 percent of the older adults aged 60 years or above live independently, and this number is projected to increase consideration into the future [10]. Altogether, this rapid age spike holds far-reaching implications for not just these

individuals, but for all others in the population, as this increases the duty of caring for the older population.

In modern times, the changing social needs of older adults cause them to suffer from difficulties in physical functioning as a natural part of aging. Due to these underlying social circumstances, new challenges impair these individuals' ability to maintain a comfortable, yet independent lifestyle in spite of their physical difficulties. These individuals now face greater needs for social support, but at the same time face greater risks of social isolation; as they require social support for a better living situation, the danger of also becoming prone to overreliance on said support leads to a lack of independence. This issue becomes compounded with their need for proper health-care, where hospital visits become more common and last longer, where healthcare issues stem from health complications that tend to be chronic and long-term in nature. Older adults will naturally be encouraged to spend more time at home, and thus are in dire need of effective home care services as well, provided either by professional agencies or more commonly, fellow family members.

It is here that the field of gerontechnology holds the most promise. Fozard et al. describes gerontechnology as a combination of the separate elements of *gerontology* and *technology*, where the former describes scientific study of aging whereas the latter is the development and implementation of technological products, services and physical environments [7]. Gerontechnology's scope is concerned with utilizing technology as a means to support a better life for aging people, hence the connection between the two fields of study [3]. This naturally relates to the potential that the usage of technology can bring about benefit to both aging and aged people [6, 8, 11], which positions it as a vital field of study in supporting older adults going forward.

While gerontechnology focuses on the impact of different technologies within five domains of human activity [8, 11], for the purposes of this paper, the domain concerned with housing and daily living (technology supporting independence, convenience and safety of daily activities among the elderly people) is of particular note. As a direct result, it is through the marriage of technology with careful consideration of aging that various issues faced within domains such as housing and daily living can be addressed.

The goals of this paper are as follows: to outline the specific issue of bathing as a healthcare concern for older adults, and the conceptualization of the iMagic-BOX portable walk-in bathtub, a series of mobile, walk-in bathing and shower units designed to assist older adults to be able to independently and comfortably bathe on their own.

2 The Problem with Bathing

2.1 The Lack of Proper Healthcare Facilities

For the average older adult suffering from mobility issues, the question of healthcare comes to light. As described by the United Nations, there is a rising trend of late for older adults to live independently, and this brings about various socio-cultural implications [10]. In other words, the demand for nursing/old folks' homes are likely to see a decline in demand in the coming future. Indeed, the Association of American Medical Colleges has declared shortages regarding the supply and demand of physicians

to provide medical care for all the facilities across the United States of America [2]. A similar situation is being seen in the supply and demand of nurses as well [1]. These developments, alongside the alarmingly poor conditions of well-established healthcare providers for the old such as those seen in the vast majority of NHS England Hospitals [5, 9], forces an ultimatum: for the average older adult wanting independence in their healthcare, without reliance on medical centres and facilities, it will necessitate opting for either homecare or family support if their physical condition ever worsens.

With this situation becoming the norm, it is often the case that for these older adults, as time progresses, it becomes increasingly likely that they will be unable to fully care for themselves. Many will either be unable to afford or simply prefer not to opt for homecare services, so the duty of caring for them falls to the rest of the family. Unfortunately, this is understandably, not possible in most circumstances, as family members have their own lives to lead and commitments to their own nuclear families, so family support can never be truly full-time.

2.2 The Inability to Conduct Self-care

In this situation, older adults will be left to tackle basic, everyday activities by themselves, despite their physical complications. In the case of ever-increasing physical difficulty, carrying out such activities such as bathing or taking a shower becomes increasingly challenging, and even dangerous. During the conceptualization of the iMagic-BOX portable walk-in bathtub, various such activities were considered, in an attempt to identify where the need for assistive technology was most needed, and eventually the answer became clear. For the sake of long-term care, bathing quickly turns into one of the commonplace activities that becomes increasingly unfeasible to carry out independently. One of the most common places of accidents occurring in the household is the washroom - a combination of wet surfaces and movement difficulties usually results in unfortunate accidents.

In a “Morbidity and Mortality Weekly Report” by the Centres for Disease Control and Prevention, they identified that in the United States of America in 2008, approximately 21.8 million persons aged 15 years or above were involved in nonfatal, unintentional injuries, incurring approximately \$67.3 billion in lifetime medical costs [4]. The key finding of the report however was that injury rates increased with age, and coincidentally, most injuries in the washroom (81.1%) were caused by falls. While these statistics do include injuries occurring on or near the toilet among others, injuries occurring in or around the tub or shower increased markedly, from 49.7 per 100,000 among persons aged 15–24 years to 200.2 among persons aged 85 years or above. In summary, these findings point the extreme dangers that come about when older adults are carrying out the act of bathing. The washroom is dangerous enough to warrant that the standard convention is for nursing home patients to only receive only a single bath per week to reduce the likelihood of accidents, while some facilities provide at least two a week [9], and this occurs in professional facilities with trained caregivers, let alone untrained family members.

2.3 The Design Failures of the Conventional Walk-In Bathtub

Market forces have been savvy to these complications, and have in the past attempted to solve the dangers of bathing with a bathtub through the concept of a “walk-in bathtub”. As such this concept is not a new one, with many existing designs, providing a large variety of such products currently available for purchase in the marketplace. The unfortunate fact is, after some analysis, several design flaws of standard designs were identified, and are as follows (Fig. 1):



Fig. 1. A standard-design walk-in bathtub currently in market

First and foremost, the walk-in bathtub’s entryway- conventionally, an inwards-opening door in the sidewall of the bathtub, a design choice that poses several difficulties. Most designs require the user to raise their feet over a step, or pass through an uncomfortably narrow doorway. This can be particularly difficult, given the physical weakness often experienced in the users’ legs during the physical motion. The inwards-opening door also poses a safety hazard, not allowing a person to vacate the bathtub in the case of an emergency without first draining the water out.

The classic-style walk-in bathtubs are also guilty of long waiting times, referring to the time taken for water to both fill and drain. This issue does not merely affect the time taken in waiting, but also negatively affect the user’s comfort as they will usually be undressed while waiting, meaning the user can be stuck waiting, wet and cold for long periods before being able to vacate the bathtub. Moreover, as these bathtubs are designed so that the user is forced into a sitting position, yet the actual water height limit will hardly reach the users’ breast, leaving their entire upper body unsubmerged. Hence, users would not be having a proper full-body bath, and this complicates self-cleaning.

Additionally, walk-in bathtubs are primarily permanent installations, installed like a regular bathtub in the washroom and are not designed for mobile usage. This forces the user to travel to the washroom to take a bath, which, as obvious as it may seem, can be incredibly inconvenient for certain older adults. For example, if an individual happens to be relatively immobile, the process of making the journey from their current location in the home (for instance, the bedroom) to the washroom where the conventional/walk-in bathtub is installed can be arduous or even dangerous in some cases.

Furthermore, the standard pricing for walk-in bathtubs ranged from \$5,000 for low-end models to \$17,000 for high-end models. These demanding prices are often-times the result of the high installation costs that are coupled with the actual price of the bathing unit itself. Altogether, the substantial monetary investment required in purchasing a walk-in bathtub is arguably unjustified as the buyer is likely to receive a product whose design elements make it unsuited to their needs. An individual could have instead used these funds elsewhere for greater benefit, as for the same cost, one could renovate their washroom to have a fully-featured walk-in shower unit, which as an added benefit, raise the value of the property.

3 Designing the iMagic-BOX Portable Walk-In Bathtub

3.1 Initial Concept Development

The authors of this paper began development of the experiential product design that would eventually become the iMagic-BOX portable walk-in bathtub in its current form. The initial design concept was straightforward: to redesign the walk-in bathtub so that it would effectively serve its supposed function, because the concept of a walk-in bathtub if well-realized held the potential to positively impact the lives of many older adults worldwide. The authors sought inspiration for its design by studying the entire process of bathing, from aspects of mobility to reach the bathtub as well as the act of bathing with a bathtub itself (Fig. 2).

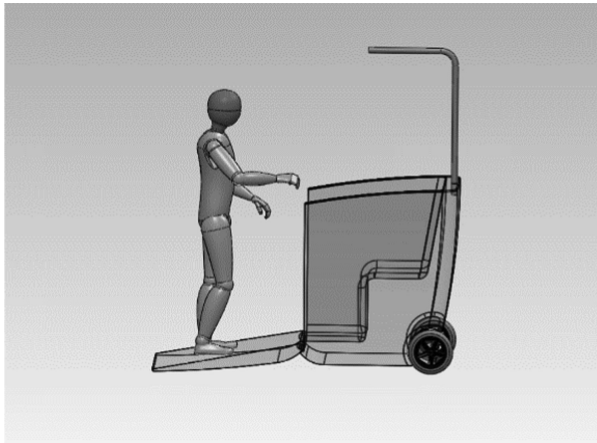


Fig. 2. An early 3D rendition of the iMagic-BOX portable walk-in bathtub

The primary inventor soon realized that the inability to self-bathe, and having to rely on another person's assistance for such a menial task could damage an older adult's pride, which could condition their bathing behavior. In extreme cases, some individuals may actively avoid the act of bathing, perhaps as an avoidance of the anxiety associated with the activity, leading to declining hygiene, putting their continued health and welfare at risk. With this in mind, the iMagic-BOX portable walk-in bathtub design was to overhaul the walk-in bathtub concept with the addition of various built-in facilities/conveniences that would accommodate for the mobility difficulties of its user.

The design methodology is straightforward: inspect each design component of conventional walk-in bathtubs and attempt to overhaul it, thus resulting in a complete overhaul of the entire product. For example, regarding the installation of conventional walk-in bathtubs, which are permanent, and the issues this causes regarding the transportation of patients, the design overhaul of this aspect was to eliminate installation altogether and make the bathing unit fully mobile instead. From here, quality assurance testing would be performed to evaluate the efficacy of the design overhaul.

Altogether, the iMagic-BOX portable walk-in bathtub was meant to cater to the same demographic as those targeted by conventional walk-in bathtub producers, primarily older adults, which usually includes the physically frail and a subset of the physically disabled such as wheelchair-bound individuals. As a direct result, specific features of the overall design were tuned to be more user-friendly to such individuals, such as ensuring very little physical ability would be required to operate the unit's controls, or that any instructional wording is of gerontological standard for easy reading.

3.2 The iMagic-BOX Portable Walk-In Bathtub Feature-Set

With consideration of the various flaws of the conventional walk-in bathtubs in mind, the defining feature of the iMagic-BOX portable walk-in bathtub design was a focus on mobility. Its build is that of an upright single-person bathing unit designed to be easily carted to different areas of the home, and easily loaded onto a vehicle for transport. The only caveat would be that the unit must generally rely on a stable electricity source and water supply, however this allows the unit to be temporarily/permanently installed in any location that satisfies these conditions. The main limiting factor is the electricity supply, however there is less need for a constant water supply (a factor which will become clearer in a later section). Thus, by eliminating the primary flaw of a permanent installation, this ties in to another inherent strength of the mobile design, cost. As previously explained, conventional walk-in bathtubs are relatively expensive products, mostly due to the high installation costs involved. By comparison, the iMagic-BOX portable walk-in bathtub aims to offer high-end value at a projected price of \$9,000, owing to the lack of installation costs, making it a far more affordable option (Figs. 3 and 4).

With regards to the issue of the inwards-facing door entrance for most conventional designs, the iMagic-BOX portable walk-in bathtub instead utilizes a drawbridge design, and has its forward-facing wall as an actual drawbridge that extends outwards

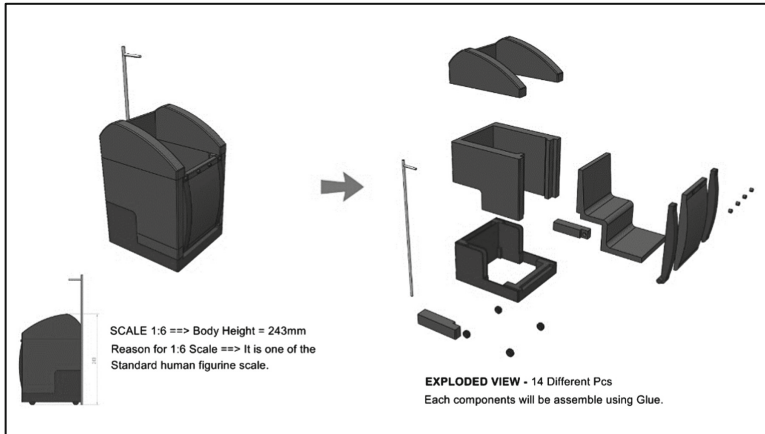


Fig. 3. The 3D-model of the iMagic-BOX portable walk-in bathtub used for 3D printing individual components



Fig. 4. 3D models comparing separate size renditions of iMagic-BOX portable walk-in bathtub units

as a ramp leading up to the unit. Hence, instead of having to step over the tub-wall/step, the user is able to walk directly into the bathtub as if it were a doorway without hindrance and sit comfortably on the high-traction bath chair within the unit. To ensure that the user is properly secured, the bath chair comes with belt restraints as an option to prevent sliding or falling off from the seat, another common hazard in conventional walk-in bathtubs. As an alternative, for wheelchair-bound users, an alternative model has the bath chair removed and the internal compartment enlarged to fit an entire wheelchair and its user, which can easily roll backwards into the bathtub using the

drawbridge as a ramp. With either design, after the user is safely in place, the drawbridge can be retracted to close the opening, forming an airtight seal to hold water; this dodges the concern of navigation through a narrow opening.

With the user now in position, the unit can begin taking in water and will fill to desired height catering to the sitting height of specific user, which will allow for the proper full-body bath not granted by conventional designs. In addition, to counter the infamous long waiting times involved with filling and draining such bathtubs, the water inlet and outlet valves installed in the unit are designed to reduce these waiting times significantly. Moreover, during the draining process, there is the option of a user-activated hot air channel to lightly dry off the user while keeping them warm. Alternatively, the iMagic-BOX portable walk-in bathtub could instead be used as a seated-shower unit instead, where an overhead shower head can be activated to provide a refreshing shower if the user would prefer one. If this function is utilized instead of the bathtub function, then the water would not be accumulated, and instead be immediately drained through the outlet valve instead to prevent build-up.

Furthermore, to assist with personal mobility of the user, the interior of the unit is ergonomically-designed, with grooves and handles built into its structure to be used to assist in the sitting-down and standing from a seated position movements in the non-wheelchair model. Additionally, the interior houses most of the control interfaces including a drawbridge toggle, shower/bath toggle, water elevation settings, water temperature settings, controls to begin filling/draining water while in bath mode, and finally an emergency water release. As added support, a bar located is on top of the back walk of the unit if the user would rather grasp it to help with sitting or pulling themselves upwards to stand.

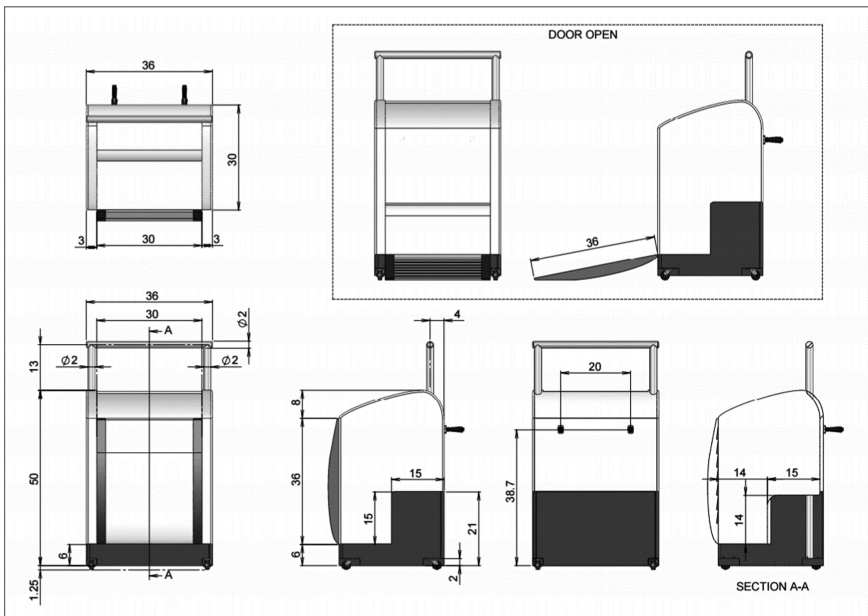


Fig. 5. Dimensions of a version of the iMagic-BOX portable walk-in bathtub

Finally, the design seeks to go above and beyond mere adherence to environmentally-friendly design; its construction allows it to take advantage of green technologies to reduce water usage and wastage. The unit is designed to utilize an external water storage tank (of varying capacity) that requires an approximate of 30 L (or 8 Gallons) of water for a shower spray bath, and double that for a full-soak bath. As an added benefit, this allows the unit to still be fully usable during the event of a water shortage, or if there is no direct water supply, with a full tank providing enough water for at least one more full-soak bath, while remaining a mobile unit. To improve this water efficiency further, the interior is outfitted with an efficient membrane water filter that is capable of cleaning and filtering used bathwater. It is efficient enough that the same bathwater can be reused several times while still being fully hygienic if needed, with the used bathwater being drained back into the storage tank for further use, instead of drainage to be expunged from the unit instead (Fig. 5).

4 Practical Implications and Conclusion

Through the combination of these specialized designed features seeking to overcome the failing of previous attempts at walk-in bathtubs, the iMagic-BOX portable walk-in bathtub aims to assist older adults in bathing independently in the comfort of their own homes, without worrying about the need to burden family members. Furthermore, although it was not the inventor's original intention, there was the realization that this design concept could not only serve older adults but also any individual inflicted with physical functioning limitations, regardless of age. While the numbers involved may not be as staggering as those for older adults, these individuals still represent a significant portion of adults in the world [12]. While not all who are accounted for in this category may be severely impacted in their daily functioning, this does not underplay the significant proportion of individuals who are. Many such individuals suffer from varying degrees of problems that range across a wide variety of daily activities, and as such are in need of specialized treatment or technologies to assist in their daily living. The real danger comes from when such individuals themselves become older, and have to contend with their already existing ailments, in addition to the general issues that come with old age. At the very least, the iMagic-BOX portable walk-in bathtub may prove useful for these individuals' bathing needs.

Moreover, the mobile nature of the unit's design has highlighted the opportunity for this style of design to be implemented in professional nursing centre settings. Considering how these facilities currently struggle with bathing their patients/clients on a regular basis, there is an opportunity to utilize several units as mobile, shared bathing units within the centre. The units' water storage tanks could be pre-filled and then the entire units moved to the location of each patient/client (their personal rooms for instance) where they can be provided a shower/bath without the need to endanger/inconvenience the patient/client with unnecessary travel.

Despite the design decisions made for the iMagic-BOX portable walk-in bathtub's current design, the authors of this paper recognize that no one design is ever one-size-fits-all, for designs must be catered to specific contexts and circumstances of its usage. With this in mind, efforts have already been made to create alternative

versions of the unit, by making drastic design changes to suit different operating conditions. The most prominent of these being the RotoBATH, a model that eschews the drawbridge design in favor of a rotating bath-only unit which would allow for the user to go from a standing position into a lying position, that being the same position a conventional bathtub utilizes.

It is this paper's authors' hope that by sharing the conceptualization process and the methodology that lead up to and during the iMagic-BOX portable walk-in bathtub's development as a fully-realized product, so that other inventors may see the increasing need for the interplay between technology and aging, and the potential that the growing field of gerontechnology possesses in combating the rising issue of ageing in populations around the world.

Acknowledgements. The authors sincerely thank the Gerontechnology Lab of Monash University Malaysia for their kind assistance in the preparation of this paper.

References

1. American Association of Colleges of Nursing: Nursing Shortage Fact Sheet (2014). <http://www.aacn.nche.edu/media-relations/NrsgShortageFS.pdf>. Accessed 10 Nov 2016
2. Association of American Medical Colleges: The Complexities of Physician Supply and Demand: Projections from 2014 to 2025: Final Report (2016 Update). IHS Inc., Washington (2016)
3. Bouma, H., Fozard, J.L., Bouwhuis, D.G., Taipale, V.: Gerontechnology in perspective. *Gerontechnology* **6**, 190–216 (2007)
4. Centers for Disease Control and Prevention: Nonfatal bathroom injuries among persons aged ≥ 15 years. *Morb. Mortal. Wkly Rep.* **60**(22), 729–733 (2011)
5. Centre for Analysis of Social Exclusion: Older People's Experiences of Dignity and Nutrition During Hospital Stays: Secondary Data Analysis Using the Adult Inpatient Survey (2015)
6. Chen, K., Chan, A.H.S.: The ageing population of china and a review of gerontechnology. *Gerontechnology* **10**(2), 63–71 (2011)
7. Fozard, J.L., Rietsema, J., et al.: Gerontechnology: creating enabling environments for the challenges and opportunities of aging. *Educ. Gerontechnol.* **26**, 331–344 (2000)
8. Fozard, J.L.: Impacts of technology interventions on health and self-esteem. *Gerontechnology* **4**, 63–76 (2005)
9. The Canadian Press: Seniors in Alberta Nursing Homes to Get At Least Two Baths a Week (2013). http://www.huffingtonpost.ca/2013/03/05/alberta-seniors-bathing-standards-nursing-home_n_2813862.html. Accessed 10 Nov 2016
10. United Nations, Department of Economic and Social Affairs, Population Division. *World Population Ageing* (2015). ST/ESA/SER.A/390
11. van Bronswijk, J.E.M.H., Bouma, H., Fozard, J.L.: Technology for quality of life: an enriched taxonomy. *Gerontechnology* **2**, 169–172 (2002)
12. World Health Organisation: *World Report on Disability 2011*. WHO Press, Geneva (2011)