



smartSTORE – THE INNOVATIVE SYSTEM FOR AUTOMATIC LUGGAGE STORAGE SERVICES AT RAILWAY STATIONS

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Summary: New integrated concepts for modern railway stations provide multifunctional benefits for travellers, local service providers and retailers. The new smartSTORE concept represents an innovative system for short term and long term storage of traveller's luggage at railway stations and at other hot spots of public transport. Thus utilizing unused free space in railway stations, increasing safety and comfort for travellers and increasing the attraction of public transport in general. The smartSTORE concept is a new technological answer to meet the demands and challenges of modern luggage depot services at railway stations. It includes a completely new boxing system and a robot to handle luggage and packages of different sizes in a self service automatic unit. smartSTORE can be used in house at railway stations and in a mobile version for big events like conferences or open air concerts, wherever depot services are required.

1. Introduction

In a study funded by the Austrian “FFG” (Austrian Research Promotion Agency) requirements and demands for temporary storing possibilities of luggage in railway stations were investigated. This study [1] provides the essential requirements and dimensions for a new storage system to be developed. As it is important to base new service offers on the real needs of future users, the real demands and expectations of travelers and other customers were carefully investigated with respect to short-term and medium-term storage possibilities.

In relation to a universal system for the rail, aviation and other hot spots of public traffic, surveys have been carried out with commuters and on shopping streets. But the focus of the system is aimed mostly at railway stations. The result is a technical development which offers railway stations the best function, but can also be used in other transport places, or hot spots of public space perfectly.

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2. The requirements from a user's perspective

80% of rail passengers would use a short-term luggage storage for a stay of more than 30 minutes for shopping, dining, etc., if the following key target criteria are met:

- Baggage check-in must be possible at waist level or lower. Lifting of luggage will be uncomfortable and undesirable.
- Luggage must be stored in sealed storage boxes where hard shell packages (suitcases, computer bags), soft packages (shopping bags, clothes, flowers, ...) and single goods (umbrellas, ...) can be included.
- Target dimensions of the individual storage boxes result in:
 - Fix width 60 cm, two depth: 70 / 100cm,
Variable height (30 to 60 cm).
- Price and cost requirement:
 - Short-term storage (up to 2 hours) should be free.
 - Storage for more than 2 hours may cost 2 € to 4 €.
- Requirements concerning timing and system performance:
 - Check-in and check-out procedures should take a maximum of one minute.
 - (Timing for luggage hand-out is more sensitive, since travelers need to reach their train on time. Therefore check-out times should not to take longer than one minute.)
 - The remaining time to delivery is therefore displayed.
- Requirements for a physio-friendly and ergonomic operation and utilization of a barrier-free equipment for people with age-related or technical restrictions (disabled):
 - Dimensional design on the basis of the values of the 95th percentile of human bodies according to the ergonomic body index. According to accessibility, the 5th percentile is used. This means:
 - The gripping space of all controls may allow a maximum of 140 cm in width. (= large gripping area, measure of the arm span of the smallest person of the 5th percentile).
 - The amount of the gripping area must be under 184 cm. (= 5th percentile of the gripping area of a woman, DIN 33403-2).
 - The lifting of luggage is supported by fact, that the height of the check in/out station can be adapted to demands of individual bodies.
 - The bottom edge of display must be located at a height of 70 cm to 1,125 cm.

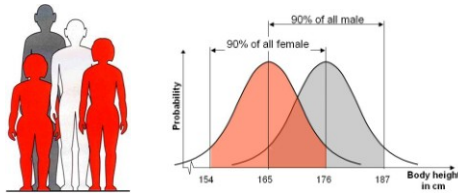


Fig.1: Ergonomic body measurements indices as basis for dimensions

- Cognitive system demands lead to:
 - An interactive user interface (touch screen) to carry out all functions for the inputs and release of luggage (check in, financial clearing and check out). Demanded are multi-lingual menus and the use of readily understandable pictograms as well as a clear chromatic support of user dialogues, but also of course, for colorblind people.
 - User-friendly and logical (= the common expectation appropriate posture) operating dialogues with the possibility to cancel operation steps at anytime and also offer online help functions.
- Demands for security and comfort:
 - Rounded bearing edges for protection from bruises and exclusive use of controls in clamping free execution.
 - Automatic control of the emptiness of storage boxes after check-out.
 - Display of filling weights (with limitation of the maximum weight).
 - Height adjustment of check in/check-out station.

3. Technical requirements

The technical variants of the smartSTORE system and its associated implementation concept address two central research questions:

- SmartSTORE must be designed so modularly to be adaptable to many different structural conditions in various railway station buildings and fixed airport terminals. For flexible use in small stations or for public events, a container based solution is provided.
- To get optimum use of space within the limited storage space for the big cubature variety of different sized bags, the use of size-adaptive variable boxes in a suitable system is necessary.
- The handling and storage technology has to be available for both, the portable containers and inside the fix buildings. The premise that a solution that can be introduced in very limited space of a 40' ISO container can also meet the requirements of complex and intricate spatial situations of railway stations and airports, may have proved to be correct.
- A container version must include all components of a building style:
 - check in / check out stations

- equipment for automatic transport and storage (system: “automatic small parts warehouse”)
- handling and storage of differently sized boxes.

The most effective variant solution found for a 40 'ISO container includes a maximum storage capacity of 80-120 variable sized storage boxes (depending on the degree of filling).

In order to avoid long waiting lines, especially at the check-out station – e.g. before departure of trains or at the end of events - the following should apply:

$$\frac{\text{amount}_{\text{check-out-stations}}}{\text{capacity}_{\text{boxes}}} = \frac{1}{50}$$

As the key element of innovation research, the concept of adaptive sized boxes was followed. It was quickly recognized that a variety of all dimensions and a block storage concept cannot be a feasible solution neither for the storage box transportation nor for automatic box detection and automatic picking.

The theoretical freedom of the mechanical design and materials selection was therefore reduced to two basic sizes of storage boxes in metal or plastic. But the height of the storage boxes should be adaptable to the size of their filling. This results in the following basic criteria of the storage boxes:

- easy filling from the top (and not from the side, as in lockers)
- coverable to protect the goods (leads to a cover version)
- size:
 - SMALL type: 750 x 600 mm
 - BIG type: 1000 x 600 cm
- height variability of both types from 300 mm to 500 mm
- maximum load: 50kg.

In a direct comparison of alternatives, criteria such as production costs, investment for box development, box stability, handling and automation, space requirements, variability, difficulty of storage and positioning, ... were taken into account.

4. The smartSTORE solution

4.1. Reliable and proven components in an innovative combination

The technical solution of smartSTORE is based on proven and reliable logistics technology components, which will be assembled and used in a new specific way to meet the conditions and demands as defined above. The basic idea incorporates the automation concepts of the small parts warehousing technology and a sophisticated solution for volume adaptive storage boxes.

4.2. The solution modules

The automatic warehouse system is the core module of the system and is primarily responsible, with its storage and retrieval technology and control strategy for the overall performance of the depot system. In figure below, there is the storage box supply which is also implemented by using conventional conveyor systems.

The innovation of the system lies in the combination of these proven elements with a unique and extremely novel volume adaptive storage box technology. The variable height of the storage boxes comprises a function to automatically cap the storage boxes before intake and to automatically open them before the swap. Therefore users only need to conciliate their luggage into the already opened storage container.

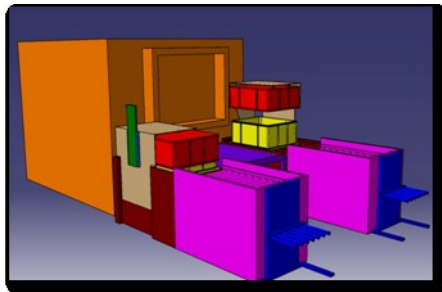


Fig.2: User friendly and ergonomic design for luggage check in and out

All containers are marked with distinct electronic chips in RFID technology to record not only their number but also the current state and their individual history.

The customer receives at the operator terminal - similar to a car park system - a deposit ticket with a unique number (in bar code and human readable), printed fare information and the documentation of the baggage deposit date. With this ticket, one can pick up his luggage at any time. The vending machine determines not only the storage time dependent pricing, but also the charge on credit cards or cell phone accounts. A cash payment should be a possible option, too.

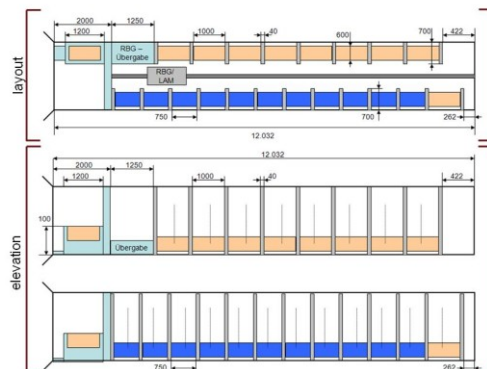


Fig.3: Principle layout of the smartSTORE container version

As an important security option is also envisaged that automatic anti-terror scanner, such as those already used at airports, can be fitted to the baggage-loading station. This device avoids intake of luggage which is identified as suspicious and can be optionally connected with a manned monitoring station.



Fig.4: Optional link to anti-terror screening modules
(photo (c) by Smiths Hermann)

5. The vision for railway station operators

In the future the effective and customer oriented design of railway stations for public transport services, as well as traffic hubs for the inter-modal cargo traffic, is an essential success factor in order to gain attractiveness and high performance of the traffic systems.

At specific inter-modal hubs the necessary transfer benefits are not only to be reached by handlings within short time limits but, on an incremental basis, there also arises the task for all carriers to temporary store, buffer and sort consignments.

Public transport requires a fast, easy-to-use and flexible depot system for temporary storing of passenger luggage that ought to replace common lockers in the long run. Accordingly, in the goods transport this merely concerns both large containers and minor shipping units like parcels.

In both cases, the variety of sizes of storing items, usually lead to inefficient and uneconomical spatial use by common systems.

smartSTORE is an innovative depot system for both packages and luggage. smartSTORE is characterized by its highest flexibility in volume and is equipped with an innovative racking and conveying technology. However, quality targets are an effective goods turnover and a high service level. smartSTORE has the potential to increase the attractiveness of public transport, in general, and specifically for the railways. New services for rail and other transport carriers may result from this development.

The intelligent and innovative logistics solution smartSTORE addresses the inter-modal transport of goods and the improvement of the public passenger transport infra-structure.

A smartSTORE prototype will be presented at the “ITS World Congress 2012 - smarter on the way” to showcase this state-of-the art technology for automatic luggage storage systems.

References

- [1] Rueger B, Graf H-C, Stadlmann B, Luggage Lockers – Needs and Expectations of Passengers, ZEL 2011, Zilina
- [2] Graf H.-Ch., Zwischenbericht SmartSTORE (September 2010), ways2go-project funded by FFG