Featured Articles

Global Deployment of Cash Management Solution with Core Role for Banknote-recycling ATMs

Koichi Tanaka
Hisao Ogata
Ryota Kawaguchi
Atsuko Uozumi

OVERVIEW: With the considerable expansion in the circulation of cash in emerging economies as they undergo strong economic growth, the adoption of automated machines to reduce queuing at banks and improve over-the-counter services has been proceeding rapidly over recent years. Because of technical issues relating to the quality of banknotes and the presence of counterfeit bills, most of these automated machines are dedicated cash dispensers or deposit accepting machines rather than the banknote-recycling ATMs widely used in Japan that are able to reuse deposited cash for withdrawals. As a result, banks face tasks associated with these automated machines that are onerous to perform, such as the frequent need to replenish, collect, handle, and sort cash. Also, the number of automated machines per capita is seen to be inadequate. The core technologies that have been developed for banknote-recycling ATMs in Japan are called "sensing and handling," and these technologies have the potential to solve major issues with cash handling in emerging economies. Hitachi aims to supply its banknote-recycling ATMs globally, and is seeking to supply solutions and services that will form part of the infrastructure of society.

INTRODUCTION

SINCE the cash dispenser (CD) was first introduced to Japan in 1969, the technology has kept pace with changing needs by evolving into the automated teller machine (ATM), incorporating numerous functions. These machines now offer a variety of services including online inter-bank transactions. They have become an important part of the infrastructure, essential to our daily lives, with approximately 190,000 machines operating around Japan.

Rapid economic growth in emerging economies over recent years has resulted in an expansion in the circulation of cash together with a surge in the number and size of cash transactions, either over-the-counter or through automated machines. The chronic congestion this has caused has become a problem at a societal level in some countries. Against this background, banks in these countries are making rapid progress on the provision of social infrastructure that will facilitate objectives such as expanding services and the use of automated machines that allow for flexible deployment, and also efficiency improvements and increasing the number of outlets and counters.

In many countries, large numbers of counterfeit or worn banknotes that are unsuitable for mechanical handling are circulating in urban areas. Most of the automated machines installed in such countries are dedicated CDs or automated deposit machines (ADMs). The number of such devices per capita is also seen as insufficient.

This article describes initiatives by Hitachi that are based on technology and experience built up in Japan and that seek to create a safe, secure, and trouble-free society through the global supply of banknote-recycling ATMs that are capable of both accepting and dispensing cash.

PROVISION OF SOLUTIONS BASED AROUND RECYCLING ATMS

The original motivation for financial institutions to introduce ATMs was to save labor by automating over-the-counter cash handling. Hitachi's aim goes beyond the supply of the required equipment and extends to supplying solutions that have the potential to provide important social infrastructure and innovation in the use of ATMs for cash handling.

Improvement in Cash Handling and Capital Efficiency

Most overseas banks return the banknotes they receive at the counter or ADM to the back office or a cash handling center. The cash is then tallied by counting the banknotes to confirm their total matches the receipt. Next, in accordance with legal requirements, the banknotes are checked manually or using a special-purpose scanner to sort counterfeit or worn banknotes from those able to remain in circulation. The former are returned to the currency issuing agency (such as the central bank). Of the remaining banknotes, those suitable for mechanical handling are selected so they can be used to stock CDs.

In addition to this back office work, another necessary task is the continual monitoring of CDs and ADMs so that they can be frequently restocked or emptied of cash to ensure they do not shut down due to lack of funds or becoming full. In the case of machines installed away from bank branches, this also requires the transportation of cash, a task made expensive by the attendant need for security.

CDs and ADMs also pose a problem of capital efficiency. Whereas CDs need to be stocked with banknotes, ADMs require their collection. Compared to the case when deposited banknotes are reused for withdrawals, this will in principle require roughly double the amount of cash and associated handling. Because this cash is not available for other investment, the loss of capital efficiency imposes a non-trivial cost, particularly in countries with high interest rates.

In contrast, a recycling ATM performs counterfeit checking, sorting, and counting of deposited banknotes automatically, identifying those suitable for reuse and storing them in its internal repository. The banknotes from the repository can then be used for withdrawals. For these reasons, Hitachi believes the recycling ATM is an effective solution because not only can it perform the back office work itself, it also reduces the amount of cash needed for cash services.

Provision of Safe, Secure, and Convenient Cash Transactions

In countries where there is a high risk of banknotes being forged or deliberately altered, not only are such banknotes frequently deposited over the counter or into ADMs, it is also not unusual for such counterfeit notes to be present in cash withdrawn from a CD. Similarly, the presence of worn banknotes in circulation is an operational problem for CDs and ADMs because it makes them more likely to jam. The tasks of identifying and separating worn banknotes, detecting and eliminating counterfeit notes, and investigating how they entered the system imposes a major workload on cash handling centers and other facilities that perform back office work.

The advanced banknote recognition functions in recycling ATMs can detect and separate banknotes unsuitable for circulation and automatically deal with them in accordance with the applicable rules. Furthermore, the next-generation banknote-recycling mechanism described below can track each banknote that passes through an ATM, including counterfeit notes, by using a function for reading the banknote serial numbers.

In this way, the recycling ATM can act as part of the social infrastructure, reducing security risks that threaten our safety and providing an environment in which users can be confident about making transactions.

TECHNICAL INNOVATION UNDERPINNING GLOBAL DEPLOYMENT

Challenges for Global Deployment of Recycling ATM

Hitachi has been working relentlessly to develop its ATMs ever since it leads the world with the release of its HT-2806 recycling ATM in the 1980s. In order to market these machines globally, however, there is a need for further development to adapt them to the banknotes and other requirements of different countries and regions.

Fig. 1 shows the technical elements that make up the cash module at the core of an ATM. Banknotes inserted by users into the bill slot on an ATM are separated and passed one at a time through

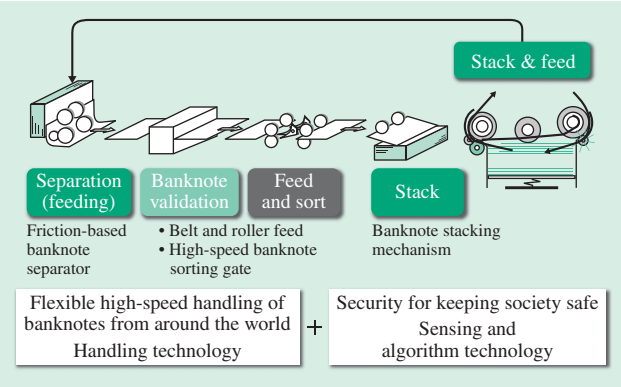

Fig. 1—Technologies Used in Note Transport Mechanism.
After being individually separated and passed through the note validator, the banknotes are sorted and then stacked.

TABLE 1. Relevant Factors for Overcoming Challenges
The table lists the factors relevant to the challenges that needed to be overcome before the cash module could be marketed globally.

Category	Relevant factors
Physical properties of banknotes	Variety of dimensions, built-in security features, paper types, and materials (polymer banknotes)
Banknote circulation	Degradation of banknotes in circulation, risk of counterfeit notes, differences in number of banknote denominations to be handled, skewing in number of notes in each denomination needing to be held due to country's choice of banknote denominations
ATM installation site	Harsh conditions due to temperature, humidity, weather, dust, and other environmental factors when ATMs installed on building exteriors, prevalence of criminal acts such as vandalism or illegal withdrawals from ATMs

ATM: automated teller machine

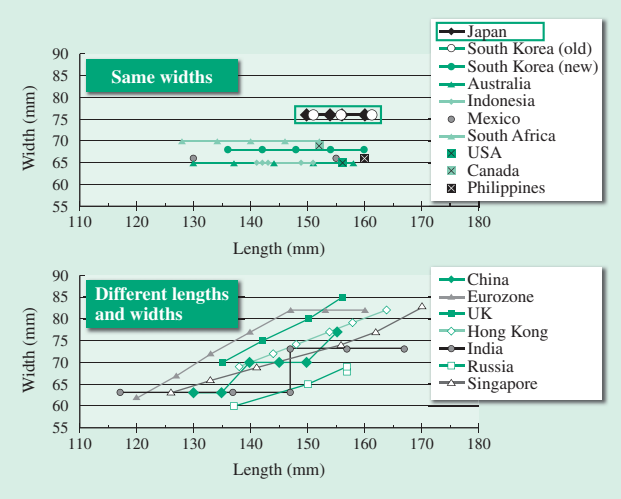

Fig. 2—Dimensions of Banknotes Used in Different Countries and Regions.
Banknotes are very diverse, with different denominations having the same widths in some countries and different lengths and widths in other countries or regions.

the banknote validator that rapidly reads their denomination and checks for counterfeit notes and whether they are torn or folded, and then on to the feeding and sorting unit that stacks them in accordance with the result of validation.

When seeking to supply ATMs developed in Japan to overseas markets, the initial challenges for the cash module related to the sensing technology, which must reliably read the characteristics of even worn banknotes in poor condition, and the handling technology, which needs to be able to feed different types of banknotes reliably without their jamming. Technical innovations were required in both cases. As obtaining the specifications for banknotes circulating in different countries was difficult, the challenges lay in studying and analyzing the banknotes from these different countries and regions to work out how to handle them and to expand the range of options able to be offered. Table 1 lists the factors relevant to overcoming these challenges.

Fig. 2 shows the differences in the dimensions of banknotes from different countries and regions, one example of a physical banknote characteristic.

Commercialization of Banknote-recycling Mechanism

Hitachi overcame the three challenges described above to release the Hitachi Cash Module worldwide banknote-recycling mechanism in 2000. With ongoing enhancements having been made since then, the unit continues to be supplied as a core module. ATMs fitted with the Hitachi Cash Module are now operating in more than 50 countries around the world, including China and India. The Hitachi Cash Module is an entry-level model for banknote-recycling that can work with banknotes in a variety of sizes from around the world by using multiple cash cassettes, a cash handling technique common in overseas CDs.

In 2009, Hitachi released the Universal Recycler (UR) series next-generation banknote-recycling mechanism and the Smart Recycler (SR) series of ATMs fitted with the UR mechanism (see Fig. 3). Hitachi has continued to develop the technology of the UR series based on the needs of different stakeholders and the problems they face, namely the operational considerations of banks, the staff who handle cash, and the ATM users. In addition to increasing cassette capacity to lengthen the time between visits to

Fig. 3—Next-generation Banknote-recycling Mechanism and ATMs in which it is Used.
The series was developed with consideration for a variety of needs and issues, including staff and the operational considerations of banks as well as users.

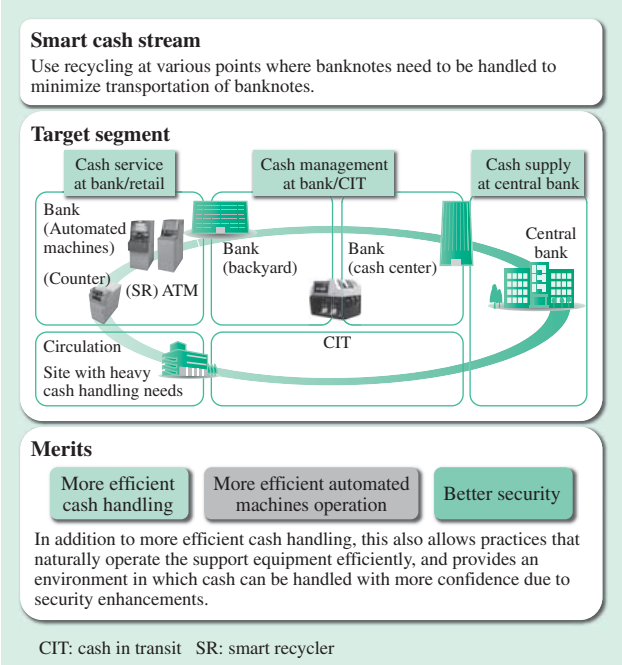

Fig. 4—Minimizing Quantity of Banknotes to be Transported for Cash Circulation.
Efficient cash handling and better security can be achieved by minimizing the quantity of banknotes that need to be transported.

replenish or collect cash, the machines are equipped with an internal mechanism for verifying the number of notes with a view to offering a wider range of solutions in the future. They also support tracking of banknotes by serial number.

In the future, Hitachi intends to develop solutions that improve the efficiency of cash handling and equipment operation, enhance security, and allow cash to be handled with confidence by using the banknote-recycling mechanism to implement banknote-recycling at different points and minimize the quantity of notes that need to be moved (see Fig. 4).

The next section describes the technologies that underpin the banknote-recycling mechanisms and solutions already in commercial use.

Sensing Technologies for Banknote-recycling Mechanisms

While automated machines need to recycle as many deposited banknotes as possible to achieve a high level of cash handling efficiency, they also need to avoid accepting counterfeit or deliberately altered notes and dispensing worn notes. On the other hand, being too strict about banknote validation will detract from user satisfaction and operational efficiency by rejecting notes that could have been accepted or withholding notes that could have been used for withdrawals. Furthermore, banknote validation needs to take place in the very short period of time between the note's passing through the validator and its sorting in the stacker.

In response, Hitachi has applied optical, chemical, and electromagnetic techniques to the study of banknotes from around the world to develop validation technologies that combine sensors and algorithms. The banknote validator performs high-speed processing that integrates data collected from sensors. In addition to identifying the denomination, it also reads the security information and features built into each banknote and uses a recognition algorithm to perform a counterfeit check in realtime.

The UR series is also equipped with technology for reading banknote serial numbers. Because it can identify individual banknotes, this function can be used for more extensive banknote tracing, in the ATM and elsewhere and including counterfeit or altered notes. It can also detect and separate banknotes that are unsuitable for circulation because they carry advertising messages or other printing, which happens in some countries.

Handling Technologies for Banknote-recycling Mechanisms

For banknote-recycling to work in practice, it must be capable of reliably feeding different types of banknotes from various countries. Banknotes come in a variety of denominations, sizes, and materials (different types of paper, polymer notes), with a lack of uniformity in the size of notes of the same denomination being not uncommon. Other problems include banknotes that have become wrinkled, folded over, creased, or torn in use, or that contain staples. Also, as ATMs can be installed on exterior walls, measures are needed to deal with extremes of temperature and humidity, or with dust in the case of sites near deserts.

In response, the cash module is able to feed banknotes reliably, even when notes of different sizes, materials, and conditions are present, thanks to the provision of an advanced note separation mechanism and stacking and transport mechanism. The cash module also reduces faults by optimizing the path that banknotes travel to shorten its length while also preventing jamming, even if notes overlap or foreign material is present. As an environmental measure, the cash module features high-speed note transport without jamming by adopting a mechanism that stabilizes the feeding force even if large changes occur in temperature or humidity. Other functions automatically remove dirt from sensors and

automatically adjust sensor sensitivity to maintain sensing accuracy and reduce the incidents of faults due to dust.

SOCIAL CHANGE BROUGHT ABOUT BY RECYCLING ATMS

Hitachi began supplying recycling ATMs to Chinese financial institutions in 2000. As in Japan, the machines were initially marketed as a solution for reducing teller workload and improving cash handling efficiency, and this remains the main reason for their installation. The increase in the number of recycling ATMs operating in China is forecast to exceed 50,000 per year in 2015, making up about 60% of all automated machines installed. Similarly, it is forecast that about 5,000 machines/year will be installed in the Association of Southeast Asian Nations (ASEAN) and about 2,500 machines/year in India (Hitachi estimate based on Global ATM Market and Forecasts published by Retail Banking Research).

The operational efficiency of recycling ATMs is at its best (the work of replenishing or collecting notes from the machines is reduced) when the numbers of banknotes deposited and dispensed are in balance. The benefits are also greater when the daily transaction volume is high. However, because past experience indicates that recycling ATMs tend to dispense more money than they take in, one challenge in further improving operational efficiency is to increase the number of banknotes deposited.

In one example, ATMs were set up to handle monthly customer payments on credit cards issued by a retail bank. This resulted in a considerable number of deposit transactions, and succeeded in improving the ATM operational efficiency by bringing the number of banknotes deposited and dispensed into closer alignment. As a consequence, to improve customer service, credit cards and the provision of ATMs contributed to each other's wider adoption in China where paying by cash has been the norm. Users are able to enjoy better transaction services thanks to the spread of credit cards. The bank benefited through higher card transaction fee income, more efficient ATM operation, and a reduction in queuing at branches thanks to more ATMs being available, leading to a virtuous circle of further customer service improvements.

By using ATMs, which have become part of the social infrastructure, customers can now feel confident about withdrawing or depositing money regardless of time or place.

CONCLUSIONS

This article has described solutions for overseas financial institutions based around recycling ATMs, and the banknote handling and sensing technologies that underpin them.

Hitachi believes that these technologies can extend the role of the automated machines that act as intermediaries between banks and customers beyond their use as a substitute for over-the-counter services, spreading a culture of recycling banknotes in ATMs and other automated machines throughout the world and delivering solutions and services that make the way people live in society safe, secure, and comfortable.

ABOUT THE AUTHORS

Koichi Tanaka
Global Solutions Business Promotion Division, Global Business Group, Hitachi-Omron Terminal Solutions, Corporation. He is currently engaged in the development of overseas service businesses.

Hisao Ogata
Global Business Strategy Department, Global Business Group, Hitachi-Omron Terminal Solutions, Corporation. He is currently engaged in the formulation of standardization strategies for overseas business. Mr. Ogata is a member of The Institute of Electronics, Information and Communication Engineers (IEICE).

Ryota Kawaguchi
Sensing Technology Development Department 1, Development Planning Division, Hardware Development Center, Hitachi-Omron Terminal Solutions, Corporation. He is currently engaged in the development of banknote readers for ATMs.

Atsuko Uozumi
Mechatronics Technology Development Department 1, Mechatronics Technology Development Division, Hardware Development Center, Hitachi-Omron Terminal Solutions, Corporation. She is currently engaged in the development of control specifications for cash modules.