Sentient Future Competition:
BIN IT! – The Intelligent Waste Management System

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ABSTRACT
Littering is an urgent problem in urban environments. Therefore, a more efficient and sustainable waste management system can implicate a higher life quality and less costs for the city authorities. We propose an RFID system that tracks pieces of waste and encourages the correct disposal by financial incentives. Our solution is easily realisable and stands out by its high social, economic and ecological relevance.

1. MOTIVATION
Around the globe, more and more litter is being thrown away carelessly or dumped illegally in streets, in public spaces or in nature. Littering and the wrong waste disposal respectively affect adversely the public order, lead to higher costs for the cleaning teams and to a diminished quality of life for society. This emerging trend has to be given due attention and appropriate measures have to be launched to counter it.

In many countries, state authorities have been working on concepts to give incentives against littering and the incorrect waste disposal. But often these campaigns tend to fall on deaf ears in society because the waste management is often organised in a far too complicated way and there are not enough incentives for a social, economic and ecological waste management. This is the reason why we have developed an intelligent waste management system that allows city authorities to tackle the problem at its roots, this means on the street or at other neuralgic places, there where littering is most obvious.

2. PROPOSED SOLUTION
We imagine that in the future the littering problem can be solved using the tracking possibilities given by the RFID technology [1]. The person who disposes the waste is in possession of a *collection card*. Is he or she throwing a piece of *waste* in a *bin* or disposing recyclable material in a *recycling container*, the *bin* or *recycling container* identifies it and a certain deposit will be credited to his or her *collection card*.

The intelligent waste management is based on four *cooperating objects* described in the following subsections:

2.1 Waste
All different kinds of consumption goods like packages of fast food restaurants, tetra packages, bottles, jam jars, cans, batteries, etc. get equipped with standardised RFID tags in the factory when they are produced.

Figure 1: Wireless communication between waste, bin and collection card.

2.2 Bin & Recycling Container
The bins and recycling containers are inwardly provided with a reader and a writer. The bins are distributed all over the cities as usual. All objects that are not meant to be recycled can be dumped there. The recycling containers are allocated at central and highly accessible locations, but they do not have the same geographical distribution density as the bins.

2.3 Collection Card
The collection card has the same size as a credit card and has an embedded writable RFID chip. Collection cards are nonpersonal and are available at no charge.

2.4 Refund Station
Refund stations are explicit desks, specialised vending machines or retailers (e.g. fast food restaurants) equipped with RFID readers and writers and connected to the global waste directory. The amount collected with the collection card is refunded here.

3. STEPS IN DETAIL
Figure 2 shows the cycle of waste within the intelligent waste management system in more detail. It includes the following steps:

Production (1) The product gets equipped with a standardised RFID tag and the number is registered in a global directory.

Purchasing (2) The product is bought by a consumer. The consumer receives a collection card.

Waste Arising (3) The product is used and waste is produced.
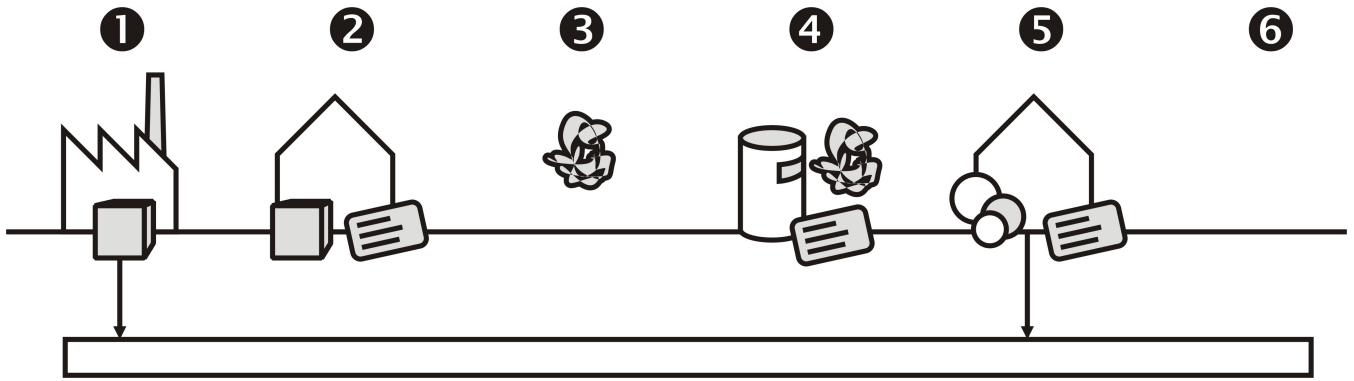
Figure 2: Cycles within the intelligent waste management system.

Waste Disposal (4) The waste is dumped in a bin or in a recycling container and the corresponding number is stored on the collection card.

Refundment (5) The amount refunded is calculated on the basis of the numbers on the collection card. The numbers of the disposed objects are removed from the global directory.

Recurrence (6) This cycle recurs at any time. The collection card can be used further on.

4. SUSTAINABILITY

On the whole, this visionary scenario is easily realisable and modifiable. It draws on all of the *three pillars of sustainability* [2].

4.1 Social

In general, the appropriate disposal of waste is of very high importance for society. The sensitisation of society for a sustainable treatment of the environment is an indicator of the prosperity of a country and it helps to strengthen the **well being** of its population. The intelligent waste management system generates a certain climate on the street that influences the waste offenders in a positive way. We can also imagine that certain persons would be attempted to collect the waste of others.

4.2 Economic

The immense costs of waste disposal that the state has to pay can be reduced by a systematic waste management policy. In states like Singapore, that maintain a very repressive policy, this system could lead to a rethinking. In addition, the producers profit from the lower production costs by the reuse of recyclable materials. But also the consumer side should be recompensed for the proper use of the waste management system by selective financial incentives. A **win-win situation** should be established.

4.3 Ecological

The use of the intelligent waste management system stops the further contamination of our environment and combats the **exploitation of non-renewable resources**.

5. POSSIBLE EXTENSIONS

The proposed infrastructure is adaptable for different needs, as described below:

If waste without an RFID tag or recyclable waste is thrown into a bin, **no money** will be transferred. This system can be expanded by defining which waste can be dumped in which bin or recycling container. The more products get equipped with an RFID tag, the more accurate and efficient it is.

To avoid possible financial fraud, a retailer such as a fast food restaurant may use the system to collect points (instead of money) in order to reward frequent clients (**customer retention**).

In a brave new world scenario, every piece of waste would be equipped with RFID tags. Therefore, an authority (e.g. the producer) could track back the origin of illegally disposed waste and **fine** the polluter on one's own account. This scenario however leads to some privacy concerns which are discussed in the next section.

6. DISCUSSION

Similarly to other RFID solutions [3] [4], **data privacy** is a severe issue. That is why we consider it as important to save only nonpersonal data on the collection card. This makes the collection card transferable from one person to another. As mentioned in section 5 above, a personalisation of the collection card could be implemented as a next step, at least for certain products.

To organise this waste management system efficiently it is important that many enterprises **participate**. Fast food restaurants (*Mc Donald's*, *Burger King*, *KFC*, etc.) that often suffer from their bad image concerning waste disposal management could profit a lot.

Further, to prevent the **abuse by the reuse** of a certain object, the reader has to be installed inside the bin or container, so that the rubbish is not identified until it is inside and cannot be taken out again by people who try to cheat.

Additional security is given by the global directory that prevents multiple refundments. The refund station verifies each number on the collection card and deletes them from the

global directory. If there is the same number on the collection card more than once, the corresponding amount is credited one time only. Therefore, a **fraud** cannot debit an item illegitimately, except he would be faster than the honest collector.

Whether the producer or the consumer has to **pay the deposit** is a controversial question as well. Concerning this matter, there are two possibilities. Either the client pays the amount of the deposit when he or she buys the item in terms of a tax rate (*polluter pays principle*) or the producer pays it. But the latter alternative is unlikely to happen without a price markup, unless the collecting card is linked to a customer retention system.

Solar cells on the top of the bins and recycling containers could provide the power supply for the technical equipment.

7. CONCLUSION

BIN IT!, the intelligent waste management system, is easily realisable from a technical point of view. On the other hand, it is of high social, economic and ecological relevance for society. These two factors combined give this visionary scenario great chances to be implemented. But the discussion shows as well that there would be some challenges to be accomplished, especially if this system should be dispersed over a large geographic perimeter.

8. REFERENCES

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