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Digital Deposit Return Schemes

A summary of their characteristics and a discussion of implemented trials.

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An introduction.

This paper serves as a guide to digital deposit return schemes (DDRSs), covering; what is meant by the term, their issues and strengths, recent trials, and the context a DDRS within the UK.

What are deposit return schemes?

A deposit return scheme (DRS) is an initiative run by a government or independent body to enable the collection and reuse or recycling of containers. Having been common for glass beverage containers for many years, these schemes have now extended to include other readily recyclable materials such as PET in soft drink bottles[1]. A DRS functions by placing an extra charge on an item at the point of sale that will be refunded to the consumer when it is recycled at a provided return point[2]. These return points can be Reverse Vending Machines (RVMs) or manual handheld scanning readers[3], often found at the point of retail[4]. Deposit return schemes have been embraced around the world, with governments using them to achieve higher collection and recycling rates. In Europe, 12 nations have implemented a DRS, the average collection rate for PET bottles among these nations was 86%, in comparison to an average collection rate of 57% for nations without a DRS[5]. Many of those nations in Europe without a DRS have now adopted legislation for the implementation of one[5]. Outside of Europe, schemes have been implemented in the USA, Ecuador, Australia, and Israel[1].



The ‘digital’ deposit return scheme

DDRSs are not as easily defined as their RVM-based counterparts; this being due to there being no existing example of a digital DRS having been implemented on a large enough scale, thus what it takes to deploy such a scheme is open to interpretation and circumstance[6]. However, considering regional trials, industry working group reports, consultancy documents and government body assessments, the conceptual elements of a DDRS can be established. Although you could be mistaken for assuming that a DDRS can be differentiated from a regular DRS for its use of technology alone, this is not quite the case. Many modern DRS systems in-fact utilise sophisticated technology to enhance their capabilities. For example, in between DRS system value chain actors certain digital ‘handshakes’ ensure that data is being shared by the different operating parties and collection infrastructure[7]. Thus, if it is not the digital aspect of the DDRS alone that makes these schemes unique, what does?



Serialisation

One of the key characteristics of the DDRS is its use of serialisation. This means that in a DDRS each product – a bottle for example, is given a unique code relating to that specific item, allowing it to be accurately tracked and traced from consumption to the end of life stage[7]. This serialised QR code could be printed on or attached to the targeted items[8].

Smartphone application

A DDRS could utilise a smartphone app, allowing users of the scheme to scan the unique codes themselves and redeem their deposits via their mobile, not requiring redemption at an RVM or manual handheld scanner[9].

The collection points

Whilst a traditional DRS would require a consumer to use the collection point at an RVM or handheld scanner, the combination of serialisation and a smartphone application allow consumers to redeem their deposits at their existing kerbside collection bins[8] or other ‘non-tech enabled’ recycling locations. Placing QR codes on kerbside collection bins would mean that users of the scheme can verify their location at the recycling point via camera, geolocation and near field communication technology[8]. Although the imposition of ‘smart bins’[8] or ‘on the go’ bins[9] in public areas have also been proposed as a method of collection for target materials.

IT infrastructure

Although a DDRS should not be defined by its use of technology alone, another distinguishing feature of schemes of this type is their potential to make use of sophisticated IT infrastructure. Due to the DDRS requiring the monitoring of numerous digitally stored and tracked uniquely serialised items, a DDRS may require either a large or advanced IT infrastructure[10]. The commonly suggested technology to facilitate such a scheme is blockchain, with the United Kingdom’s DDRS Industry Working Group[9], early proponent of the DDRS - Re-Universe[11], and not-for-profit organisation Reloop[12] all citing blockchain as a potential IT platform for the digital management aspect of a DDRS. However, further commentary has suggested that a DDRS could alternatively be supported by a large central or cloud database[10].

The DDRS

A DDRS can be then described as an innovative recycling initiative that aims to refine the traditional DRS by allowing consumers to redeem their deposits from the comfort of their own home or on the go through the use of serialisation, a smartphone application, a kerbside/smart public collection methodology and a sophisticated IT infrastructure.

Different types of digital return schemes

Despite the general interpretation of the DDRS being that which has been described above, there are some observable exceptions. Certain proponents of innovative DRS systems have opted to modify the formula, omitting certain elements of the conceptually established DDRS. This possibly being on account of a holistic implementation being so difficult at present[10] or because of the established strength and availability of traditional approach elements[6], resulting in the manifestation of hybrid approaches.

'Smart' DRS

One of the emerging systems described above is that being trialled in Serbia in the city of Zrenjanin. This trial made use of unique serialisation, a mobile phone application, smart E-bins[16] and a comprehensive IT infrastructure[13]. However, kerbside collection is not supported by this scheme[14] in this trial phase, this being seen by many as a core component of the DDRS concept[15]. This scheme instead opted to utilise RVMs and handheld scanners, for its return points - features of the traditional DRS[3]. The trial aimed to improve upon the traditional DRS model, reducing fraud via serialisation, increase the scope of collection methodology by making use of smart bins and utilise a mobile phone app to provide a platform for consumer information and reward redemption for recycling, thus incorporating most of the elements of the DDRS[16]. This approach has consequently been dubbed a 'Smart DRS' by the scheme organiser[16].

Digital Incentive Return Schemes (Reward Schemes)

Due to DDRS and DRS initiatives requiring the imposition of a deposit on a range of products, thus necessitating committed interplay from governmen[t6] and a DMO – a deposit management organisation responsible for the administration of such deposit . Consequently, many trials fail to mandate a deposit, presumably because most trials have so far been small in size[10] thus not possessing sufficient authority or scope of those in the supply chain[10] to facilitate the collection of a deposit within the trial area. As a result, the majority of the trials that have taken place have been reward based, this not being considered a true reflection of what a digital deposit scheme would look like, such schemes subsequenty being defined as digital incentive return systems[6].



The advantages of a digital deposit return scheme

Although the DDRS is often still considered a concept[6] and requires much further consultation and development, current research and successful trials paint a picture of some benefits of DDRS when compared to a traditional DRS. It should be noted; however, that the below are noted as 'purported' benefits, as a consequence of the DDRS still being in development, there is no easy comparison to the conventional DRS and as such many benefits are conceptual or based on context-dependent scenarios.

The advantages of serialised packaging

Fraud prevention

Serialised packaging in a DDRS could serve as a mechanism to prevent against fraudulent deposit redemption, being that every individual item would have a traceable unique code that is deactivated once the deposit has been redeemed[15]. This being in contrast to the potentiality of fraud in traditional DRS systems in which packaging is not serialised and tracked. Fraud as a result has had a significant impact on traditional DRS initiatives in the United States and other systems outside the US[18], such systems being widely utilised and successful for traditional DRS initiatives[19].

Supply chain visibility

Serialisation of packaging could also provide multiple benefits by enabling those in the supply chain greater and more accurate visibility of a packaging's lifecycle via increased traceability, allowing for industry and policy objectives to be accomplished more effectively[20]. For example, serialised packaging provides an opportunity to track individual items at scanning points, creating an opportunity for the collection of robust waste management data with the aim of improving recycling practice[10]. However, research surrounding the benefits of greater visibility of packaging as a result of a DDRS has also suggested that serialisation could aid litter prevention by tracking littered items[10].

Additional benefits

Further, less sustainability-centric benefits could also be realised; serialised packaging and additional scanning points would provide producers with information on consumption patterns; therefore, presenting opportunities for consumer engagement[10].

Integration into kerbside recycling

Previous investment in kerbside infrastructure

A key benefit of DDRS could be the ability to utilise existing recycling systems, in particular kerbside collections infrastructure, which may have already been heavily invested in. This would be particularly the case in the UK, which has focused on developing an effective and efficient kerbside recycling service. The Welsh system in particular being among the best in the world[21]. As a result, it has been noted by some within industry that investment in an alternative form of collection may seem counter-intuitive[22]. Thus, the DDRS, aligning with the UK's existing collection provision, could potentially mitigate the cost of further investment in collection infrastructure. For instance, in comparison to a DDRS, the imposition of a traditional DRS, which the UK currently lacks the infrastructure for, may be; more expensive due to the installation of new RVMs[26], pose a risk to current kerbside collection by diverting material and thus revenues away from local authorities[23], take longer to mobilise due to its reliance on the manufacture and installation of RVMs[26] and present a burden for certain retailers required to host RVMs[24]. Thus, it could be argued that one of the key benefits of the DDRS for the UK is that its implementation would suit the current collection infrastructure context the UK finds itself in, changing such infrastructure being a potentially costly policy change that does not utilise the current recycling culture and habits of the British public.

Lower carbon output

It has been reported that a DDRS may yield a lower carbon output than a traditional DRS. A report commissioned by the Irish Waste Management Association and completed by SRL Consulting compared the carbon impacts of a DDRS to a conventional DRS. The result was that a digital DRS would incur a saving of 20,000 tonnes in carbon dioxide equivalency (CO_2e) in comparison to its established alternative[25]. This saving comes as a result of less 'dedicated' trips to collection points (trips to an RVM solely for the purpose of delivering in scope materials to a return point), such trips not being as common under the DDRS as consumers can redeem and return items at home[26]. Although it has been stated that a traditional DRS would not require dedicated trips as consumers could return items during their weekly grocery shop, the above figure assumes that a percentage of trips would inevitably take place and its estimate is considered conservative by the authors of the study[26].

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Use of sophisticated technology

Convenience

One of benefits of the employment of advanced digital technologies in a DDRS is convenience. Through the usage of a smartphone application, supported by an IT infrastructure that facilitates the provision of a deposit and keep track of redeemed items, consumers would be able to redeem deposits from their own homes or at on-the-go bins[25]. This represents a potential boost in convenience for consumers, eliminating a journey to a return point thus requiring less effort, expenses, and time to redeem deposits[25]. This is supported by a small but ever-present proportion of consumers in RVM-based DRS initiatives that will not return items regardless of the level of deposit[25]. This sentiment being mirrored in a consultation on the DRS, in which 30% of respondents stated that an RVM-based DRS could pose a transport-related inconvenience[26]. An increase in convenience through the implementation of a DDRS in place of a DRS could have some residual effects too; such as a higher participation rate and potential decrease in littering with the inclusion of on-the-go bins[25].

Fraud prevention and data capture

However, there are more direct benefits that the greater emphasis on digital technology in a DDRS also allows for. Another level of fraud prevention is a commonly purported benefit, there being the scope for AI[11], blockchain and geolocation technology usage in fraud detection and surveillance, making the system more secure[25]. Whilst used in tandem with serialisation and its aforementioned benefits, the digitalisation that a DDRS promotes would also allow for detailed data capture. The utilisation of data management systems, such as blockchain, being able to track/manage redeemed deposits and items moving through the supply chain[25]. This allows for data collection relating to consumption metrics, packaging formats deposited, redemption locations and waste collection data via greater visibility of collection and recycling rates[25]. These benefits being realised via the combined utilisation of serialisation and advanced IT infrastructure.



The potential issues posed by implementing a digital deposit return scheme

There are some potential issues that the implementation of a DDRS could present. It should be noted here that this section intends only to provide the discussed potential issues with the implementation of a digital deposit return scheme and does not represent documented issues with nationally implemented DDRS trials.

Over-reliance on emerging technologies

Serialisation in the beverage industry

First and foremost, one of the purported weaknesses of a DDRS is that it could have an over-reliance on emerging technology that is not yet ready to be implemented in this specific scenario[12]. For example, although serialisation is very much in place in other industries, tobacco, alcohol and pharmaceuticals being largely serialised in international markets[7], it could pose some issues for the beverage industry. There is still an immaturity regarding serialisation in the beverage industry[7]. As such, it is often cited that certain identified obstacles, for example certain technical problems in the serialisation of beverage containers have not yet been addressed sufficiently. For instance, printing codes on cans/multipacks and maintaining high printing speeds whilst printing extra labelling on items are often raised as potential issues for the current inception of a DDRS[10]. However, insight provided by a technology provider for one of the trails described below, indicated that the printing and labelling technology is available to address these issues and is in fact in place elsewhere. Despite this, another consequence of such immaturity is that a uniform solution is yet to exist, and different proposed solutions for serialisation disadvantage different parts of the supply chain[10], as such it may be hard to establish a holistic solution in the short term.

Data privacy

A further issue that a reliance on emerging technology could present is that of data privacy, as DDRSs can harvest valuable and detailed consumer and product data[25]. Current conceptions of the DDRS do not specifically address how consumer data would be used[6] and who would own the data[10]. This issue is cited as having potential to discourage users from engaging with the scheme, being unwilling to share their data if the benefits of participation are not perceived to be great enough[12]. Although this research has indicated that any consumer data would be collected via a smartphone application, and such application would have to comply with General Data Protection Regulation (GDPR), thus compiling any more data than would be legally necessary would be problematic[28].

Digital exclusion

Additional concerns raised on the subject of the DDRS' embrace of digitalisation centre on digital exclusion. The digital nature of the DDRS requires participants to utilise a mobile smart phone, have a digital payment method set up and reliable internet connection[12]. Thus, the scheme may alienate a certain proportion of the population from taking part in a DDRS, as there are several reasons that people may have chosen to engage in or have to succumb to digital exclusion[28]. Such reasons: including a lack of confidence in the use of technology or being unable to afford a device or internet connection[28]. As such, the argument is that if the DDRS, allowing facilitating the redemption of deposits via mainly digital methods, is to compound any effect of digital exclusion on already socioeconomically vulnerable populations, it must be considered with caution.

Costs of abandoning a traditional DRS in favour of a DDRS

In such a move towards a greater dependence on technological advancements, a DDRS may be exposed to opportunity costs synonymous with the abandonment of a proven conventional DRS system. This research has identified three such costs

Contamination

Contamination may be more apparent as a result of one of the DDRS' strengths, its reliance on kerbside infrastructure. A lack of monitoring in kerbside recycling could result in higher levels of contamination in collected material for example[29]. Although it should be noted that implementing a DRS would separate target material initially at the collection stage of the material, but material could likely be mixed with other non-DRS material and product residues at the re-processing stage[28].

Lower quality yields

The second being much in relation to the first, it being suggested that a DDRS would yield an overall lower quality of material than a conventional DRS, on account of a DRS' dedication to collecting a more defined range of particular products i.e. recyclable drinks containers[25]. Thus, avoiding issues that contamination can cause in kerbside waste collection infrastructure and thus generating a higher revenue than a kerbside based DDRS[25]. Arguments of this nature find wider support in on-the-go bins being notoriously troublesome for contamination[25].

Participation rates

Finally, as a result of the DDRS' proposed shift in methodology away from the traditional and established RVM based return system, a DDRS could suffer from lower participation rates. For example: it has been suggested that the RVM model encourages a beneficial consumer gesture behaviour, triggered by the utilisation of return points, that facilitates a high participation rate and thus increases capture rates[6].



DDRS trials

This section of the paper describes some of the recent trials of DDRS and their significance in the development of the concept. It should be noted; however, that most of the trials below are not considered to be DRSs and would be more appropriately described as incentive/reward schemes, as many of the trials do not include the imposition of a deposit, despite the trials attempting to mimic a DRS in order to gauge the concept's legitimacy.

Zrenjanin, Serbia - 2023

Project outline

In Serbia, in the city of Zrenjanin, a project headed by Reverse Logistic Group (RLG) and in cooperation with organisations; Solagro, Sekopak, Ball Corporation, Mercator, NALED and GIZ , has aimed to trial a smart DRS system[16]. It ran from early in 2023 until the third quarter of the year[31]. The project aimed to pilot a system that would build on the concept of the traditional DRS by utilising smart labelling and mobile technology to enhance the conventional DRS system, increasing the scope of materials the DRS could handle, improving its transparency, to raise the level of consumer convenience[31] and decrease fraud[16]. As mentioned in the 'Different types of digital return schemes' section of this report, the Serbian project would be considered a 'smart DRS' rather than a DDRS[16], on account of its hybrid approach. This hybrid approach utilises return points that are components of the traditional DRS approach but is supported by a mobile phone app, smart bin infrastructure, serialised labelling and comprehensive IT infrastructure[30]. Although kerbside collection is not supported by this system, thus RLG has defined the scheme as a 'smart' or hybrid DRS[30]. However, on account of there not being a deposit attributed to in-scope products and instead there being a discount offered to consumers to use in store, this scheme should also be defined as an incentive scheme rather than a deposit scheme, although this is often the case where trials are concerned[6].

Results

Unfortunately, the RLG project did not achieve the collection target it had hoped to, the scheme attributed this largely to project scope and awareness – citing the need for a greater number of retailers to participate and delays that impacted the organisation's ability to promote the project[30]. However, the scheme does represent a success in terms of the trialling of a largely digitalised return scheme mechanism, being able to track serialised packaging, administer digitally redeemed rewards and collect data on consumer behaviour; particularly the preference of return points – RVMs in this case were the popular option[30].



Conwy, Wales - 2021

Project outline

The trial in Conwy was facilitated by the Welsh Government, Conwy County Borough Council, Polytag Limited (the technology provider) and Wrap Cymru with the aim of testing how well a DDRS might function in Wales[32]. They were particularly interested in how well the technology could be used to support already present kerbside collection methodology and how users might react to the technology[32]. Running over a four week period in 2021, the trial provided 325 out of a 579 households in the Colwyn Heights collection round area with an information pack concerning the scheme, information on how to download and register for the relevant Polytag mobile phone app, a unique QR-coded sticker for their regular kerbside recycling box and 6 QR coded 1.5 litre plastic water bottles to consume over the four week period[32]. Participants of the trial were to scan the coded sticker they had placed on their kerbside recycling box, scan the code on the bottle once they had been consumed and place them into their kerbside recycling[32]. Upon scanning a bottle, a resident would redeem a 20p donation alongside a matched donation from Polytag to the local primary school at the end of the pilot, this being used as a mechanism to increase participation[32]. On two occasions during the trial a collection crew would come to collect to the recycling, scanning the label on the recycling box or the individual bottles themselves[32].

Results

The published results of this trial include some quantitative and qualitative data. Data collected during the trial confirmed that 97% of households that registered for the app scanned at least one bottle, 90% scanned more than half of their bottles and 73% scanned all their bottles[32]. The trial also established an 89% recovery rate of scanned items[33]. This qualitative data implies a high participation rate, whereas post-trial reflections and qualitative feedback also highlight positive outcomes of the trial. Such positive outcomes concerned[33 32]:

- An apparent lack of technical support required for consumers using the system.
- Reports from households that the system was easy to use and integrate into existing habits.
- The technology, facilitated by Polytag, was also noted as familiar to the community that engaged with the trial as a result of the previously utilised Covid-19 track and trace smartphone apps.
- Positive perceptions of the information packs explaining the project.
- Ease of use of the system informing continued participation.
- Overall views of the pilot of surveyed consumers that indicated the majority of such consumers viewed the project positively and were likely to recommend its usage.
- A strong preference for a DDRS over a DRS was noted.
- The establishment of a preference among waste collectors for the scanning of UV bottle code when collecting in scope DRS items over scanning the QR code on the recycling box – this being deemed to be much quicker.

There were; however, some noted shortfalls of this trial, these being reported in a qualitative manner. The more negative reflections or feedback that were highlighted are as follows[32];

- There were issues with the scannable QR code stickers placed on kerbside recycling infrastructure. Consumers being confused as where exactly to put the stickers and collection crews struggling to find the stickers as a result, or in some cases the stickers were lost or damaged.
- A post-trial review question centred on the implementation of a DDRS attracted mixed reviews. Concerns being raised including; if a DDRS is to be implemented that there may be a fatigue felt by consumers if they had to scan every bottle going forwards on from the trial, a worry that certain consumers who are not as confident with technology may struggle and that an extra cost to bear may be angry consumers who already feel as though they are effective recyclers.
- Smartphone and technology issues were cited in the post-trial review and focused on.
    - codes sometimes being difficult to scan and requiring a back-and-forth movement or minimal movement to read the code,
    - concerns surrounding the use of a digital scheme in dark or geographic regions with poor internet connection, and
    - that crushed items/damaged labels had resulted in difficulties during the scanning process.

These results seem to display an overall successful trial of a DDRS whilst highlighting some potential issues that could occur in a national rollout of such a scheme.



Conducted across 2,000 households in the region, the trial aimed to mimic a deposit scheme by utilising a financial incentive

Whitehead, Northern Ireland - 2020

Project outline

This trial was conducted in Whitehead, Northern Ireland, and ran from September 2020 until the end of January 2021[34]. Re-universe was the technology provider and ran the trial in conjunction with Bryson Recycling and Mid and East Antrim Brough Council[34]. Conducted across 2,000 households in the region, the trial aimed to mimic a deposit scheme by utilising a financial incentive[32]. The incentive in this this case being 10 and 20p rewards that could be redeemed upon the recycling of in-scope materials through the appropriate smartphone application[34]. In-scope materials were single use beverage containers such as plastic drink bottles; including HDPE milk bottles, soft drink cans and wine bottles that were attributed a uniquely coded sticker in a local SPAR store[35]. The trial's chosen collection methodology was kerbside recycling infrastructure supported by four on-the-go bins in areas where littering was common, these bins having a QR code that they could scan before scanning the unique code on the item[35]. Although there is little mention of the sophisticated technology used in this trial and AI and blockchain not being included, such technologies were cited as being implementable alongside a greater roll-out of the scheme[34]. Re-universe does however state that trial data provided what item was scanned, where how and by who[34]. This suggests a sophisticated IT infrastructure benefitting from geolocation technology and thus a trial that embraces the four elements of a DDRS described in this paper.[36 37]

Results

In terms of results, an independent analysis was provided by The University of Belfast and provides feedback gathered via a survey[36]. This research identified little published in-trial quantitative data concerning engagement or the like, although the Irish Waste Management Association had stated that the trial was too short to achieve a high return rate and much of the labelled stock remained on the shelves[26]. Research conducted surrounding DDRS specific insights found that respondents:

- Had positive perceptions of the idea of introducing a DRS system in the UK.
- Would prefer to use a DDRS over a conventional DRS (86%).
- Perceive a DDRS as requiring less effort than a conventional DRS.
- Would recycle more in a DDRS than a DRS.
- State that the level of deposit would need to be higher under a DRS to incentivise their recycling.
- Would prefer to recycle their waste at home (70.5%).
- Found the smartphone application easy to use (86%).
- Found the smartphone app easy to download (95%).
- Did not make much use of the on-go-the infrastructure.
- Reported a difficulty in scanning items (19%).
- Would not have an issue with downloading a smartphone app in a potential DDRS scheme.

This seems to above all highlight an important preference for a DDRS system alongside its perceived convenience and how easy the application was to use whilst trialling the integration of the core DDRS elements. The lack of published data on engagement however makes it hard to comment on how successful this trial was in terms of items recycled and overall participation in the scheme.

Dublin, The Republic of Ireland - 2021

Project outline

This trial was also conducted by Re-universe in partnership with the Irish Waste Management Association (IWMA) and Panda[38] (a recyler[26]). This is one of the few trials that this research has covered that was able to implement a deposit rather than opting for an incentive[38]. Using milk packaged in HDPE as the trial item, a 25c deposit was placed on every 75c litre of milk that was delivered to 200 participating households, with milk being delivered twice a week over a 4-week period[26]. Aiming to track packaging from delivery to its arrival at the sorting facility, prove the convenience of a DDRS[26] and establish whether the return rate would be comparable to that of a conventional DRS, this trial ran for 4 weeks[39]. The trial utilised all of the core elements of a DDRS, alongside hand sorting verification at the MRF stage[40].

Results

Results for this scheme seem to be largely positive. Of the 700 items delivered, 644 (94%) were deposited. However, due to complications with the collection system, the trial team limited the deposited number to 572 to consider the recovery rate, having identified an amount of material that had been missed by the collection crew[40]. Of this deposited 572, 492 containers were recovered at the hand sorting stage, representing an 86% recovery rate[40]. The analysis does note that despite distributing clear consumer instructions on how to recycle the containers at the kerbside, separation was quite laborious with some containers being damaged and stowed away improperly by consumers, alongside a percentage of material being compacted in the collection truck[40]. However, the trial did elicit some consumption pattern data concerning the timeframe of milk consumption, displaying an advantage of tracking packaging through its lifecycle[40]. This trial represents a viability for the DDRS and demonstrated some added value benefits .

The Polytag, Ocado and Bower trial - 2023

Project outline

One of the most recent trials covered by this research was conducted by technology provider Polytag, online supermarket Ocado and the smartphone recycling application administrator Bower[41]. From Mid-July in 2023, consumers across Wales and England were able to scan uniquely QR-coded milk bottles and redeem 20p rewards via a smartphone app for recycling the bottles in their kerbside bins[42]. This trial represented an advanced trial of a DDRS system, printing QR coded labels on bottles rather than applying QR-coded stickers to in-scope products, covering a large cross-border geographical area, facilitating automatic one-time redemptions via complex IT infrastructure and the development of invisible UV scannable labels capable of verifying recycling collections at the recycler[42].

Results

Looking at the results, the trial may represent one of the largest and most sophisticated successful DDRS trials to date. Having reached over 3,000 consumers[41] that redeemed the deposits on 20,000 milk bottles[42] in a 56 day period, this means that 7.5 bottles were recycled per consumer at a rate of 350 bottles a day[42]. Further results gathered via survey indicated that 87% of those that scanned a product also recycled the packaging, 93% of those surveyed had a positive outlook on the idea of a DDRS, 71% of consumers would prefer to use a QR code to redeem a deposit whilst 58% would prefer the RVM based model[42]. The survey also indicated an 85% conversion rate with regard to how many Ocado customers registered for the Bower app – displaying a consumer interest in redeeming rewards via recycling[42]. Such results demonstrate firstly a successful implementation of an advanced DDRS system across two nations and secondly positive perceptions of a DDRS. However, little data on recovery rate beyond the reported recovery rate seen above has been published, although Polytag stated this would be released to Ocado, giving the retailer their first glimpse at verified recycling rates of a specific product line[42]. Polytag were also able to confirm that their UV scanning technology at the point of recycling was able to pick up a portion of the target items and verify they reached the re-processing stage[28].

Brecon, Wales - 2023

Project outline

The trial in Brecon, headed by the DDRS Alliance in cooperation with Welsh Government, WRAP Cymru, Powys County Council[43] and support from Danone, Nestlé, Aldi, Co-op and Morrisons[44] ran in the small Welsh town from July until November[45]. Placing QR-coded stickers on all soft drinks including cartons, cans, plastic and glass bottles in the majority of retailers in Brecon, these codes could be scanned via a smartphone to redeem rewards of 10p after the items were returned to a kerbside recycling bin[43]. However, consumers could also use retailers participating in manual over-the-counter takeback, an RVM or a community bin, with the automated machine and over-the-counter methods not requiring the use of a mobile phone if the participant did not have one[43]. Around 1,300 households out of a potential 4,300 took place in the trial[44]. The Brecon trial then represents a largely digital DRS trial, via the utilisation of a smartphone application, serialised traceable packaging, and integration into kerbside recycling infrastructure, with the inclusion of traditional infrastructure.

Results

Reports released during the trial show that 75% of those that took part had been using the kerbside recycling infrastructure whilst 25% opted to use the return machines set up at the point of retail[44]. Whilst the DDRS Alliance also employed a sampling technique during the trial to verify that items scanned were going in the correct bins, the sampling technique considered 400 participating household recycling bins and found that compliance is between 90-95%, largely suggesting that people would place the item scanned in the correct bin after redemption of the deposit[44].

Over the course of the trial, 18,794 rewards were claimed, and the positive results detailed at the end of the trial demonstrated that 58% of all returned containers came through the household weekly recycling collections, but that a range of return options was preferred over any particular route. 97.6% of all containers returned at home were captured in the recycling stream there was no significant fraud or misuse of the system; and despite this being deemed to be an early trial in the evolution of DDRS systems, 56% of participants surveyed said they would recommend the scheme in the future.

The key highlights of this trial are then that an observable preference for kerbside recycling can be seen, with other trials receiving this information by survey alone the Brecon trial is able to provide a form of evidence, and that consumers seem to be (at least in the case of the Brecon trial) allowing the scheme to function as intended i.e., recycling if a reward has been redeemed.

Other trials worthy of mention

This section of the paper has intended to cover the largest and most significant trials to date that are employing all or nearly all of the conceptual elements of the DDRS. There are however trials worth noting that have used certain aspects of a DDRS that could shed further light into the validity of a potential DDRS system. For example, other works completed by Polytag include standalone trials of DDRS elements such as traceable QR-codes that do not compromise printing speeds whilst allowing for consumer engagement opportunities for producers[46] and UV tags readable at the point of recycling[47]. Another trial which took place in Glasgow and aimed to trial how the usage of a mobile phone app and digital wallet could support a traditional DRS system. Through the app consumers could redeem 20p rewards for returning purchased plastic bottles to convenience stores participating in the scheme[48], although this research could identify no results.

Outside Europe a trial along the Kedarnath pilgrim trial headed by Recykal and the Rudraprayag District Administration in India has achieved national recognition, being awarded the Digital India award for a 'Digital Deposit Refund System'[49]. With the aim of addressing the issue of litter along the trek, the initiative allowed consumers of QR-coded plastic bottles from local retailers to redeem a deposit that had been placed on the items through their mobile phone app after they had returned their used bottles to a collection point[49]. It has been reported that the initiative had stopped over 163,000 bottles entering Himalayan nature whilst providing jobs and a potential additional source of income for those living in the area[49]. Although this trial does not include kerbside collection infrastructure, it does seem to use the other DDRS elements, resulting in an innovative scheme with a positive environmental and social impact[49].

What to consider when thinking about the trial results

Much can be taken from the results of the trials above; however, some aspects of trials and their results should be highlighted for consideration when reflecting on the either positive or negative trial outcomes. Firstly, as mentioned few of the trials above were able to implement a deposit and often substitute this with a reward. The mechanisms illicit different psychological affects, with deposits being more psychologically effective in inducing the desired behaviour than bonus/reward incentives[50]. As a result, it may be the case that participation rates in schemes utilising only the reward element may have been higher had there been a deposit.

Secondly, much of the above results that concern perceptions of DDRS systems may have to be considered quite lightly as they could be affected by sample bias. As it is often the case that participants have voluntarily taken part in the trial, this type of scheme may have been of interest in the first place and thus is reflected in their subsequent survey answers, whereas for those who have chosen not to partake for whatever reason do not have their views reflected in the survey. These survey results can certainly be considered valid as they still indicate a consumer preference, it just may be that more research is required to present a fuller picture. This requirement for further research goes further too, although these trials prove that the technology largely works and can work with high customer satisfaction rates, a full scheme across all products that may include in a DRS inclusive of every DDRS element in full capacity at a large scale should be implemented to validate the effectivity of a DDRS and without such a trial, questions may still remain unanswered.



UK context considerations

This section discusses some considerations that have been noted by literature on the subject concerning the implementation of a DDRS in a UK specific context.

Timing of current UK policy

EPR and Simpler Recycling

As the UK intends to enact its own extended producer responsibility (EPR) legislation[51] it should be noted there are potential benefits of implementing a DDRS alongside EPR. For instance, with the need for increased material verification at material recovery facilities as a result of impending EPR legislation, this could mean that some of the costs that would be associated with an element of the DDRS would already be aligned with policy objectives[20]. Such an increase in digital verification technology would also allow a DDRS to separate in-scope DDRS material from EPR material[20]. Furthermore, the DDRS could benefit the initiation of EPR legislation by utilising the detailed collected data on recycling collections available under a DDRS system to inform EPR mechanisms such as modulated fees[25]. The DDRS may align with more policy ambitions; however, the forthcoming simpler recycling legislation and the DDRS both being in support of multi-stream collections at kerbside[10].

Conflicting systems

On the other hand, a step toward a digital system could present issues for producers under the implementation of a DDRS in the UK. Scotland was set to become the first UK nation to implement a DRS scheme and had settled on adopting a traditional RVM-based methodology[20], and in Wales there has been policy direction to including a different scope of materials and formats to those proposed in other nations. The differentiation of DRS systems could render a DDRS solution uneconomical. Stakeholders have suggested that without a uniform system for the whole of the UK, the costs that come with serialisation if the scheme is to affect only part of the UK may be too much for producers, the smaller the area affected by a DDRS, the greater the financial burden for producers[10]. This effect was reported to already be discouraging producers from selling into some markets within the nations market, on account of the financial burden new DRS labelling requirements represent[10]. As a result, conflicting systems within the UK may over-encumber producers.

Delays

In the current political climate, policy makers may also want to consider whether the DDRS will add any significant delay to the roll out of a DRS strategy. Delays in the Scottish DRS[52], EPR and simpler recycling legislation[53] may have a compounding effect on government credibility, considering that stakeholders were concerned the impact the delay to rest of UK's DRS may have on perceptions of the government both domestically and abroad[54]. Consequentially, the prospect of a pivot towards a DDRS; bringing with it the potentiality for further investigation[10], may need to reap benefits large enough to justify a conceivable further delay and any associated risks.

The state of digital exclusion in the UK

As a consequence of the DDRS' potential to compound the effects of digital exclusion, the state of digital exclusion in the UK should be considered. In 2018, it was reported that adult 'non-users' of the internet stood at 10% of the UK population[55], whilst other research has suggested that around 100,000 households do not have access to internet and that this could be attributed to partially to cost[28]. Thus, the UK must tread carefully if it is to implement a deposit on commonly purchased items, as if there is a section of the population already financially strained enough to not be able to afford digital services, the imposition of a digitally redeemable additional cost may simply function as a further enforcement of digital exclusion and financial instability.

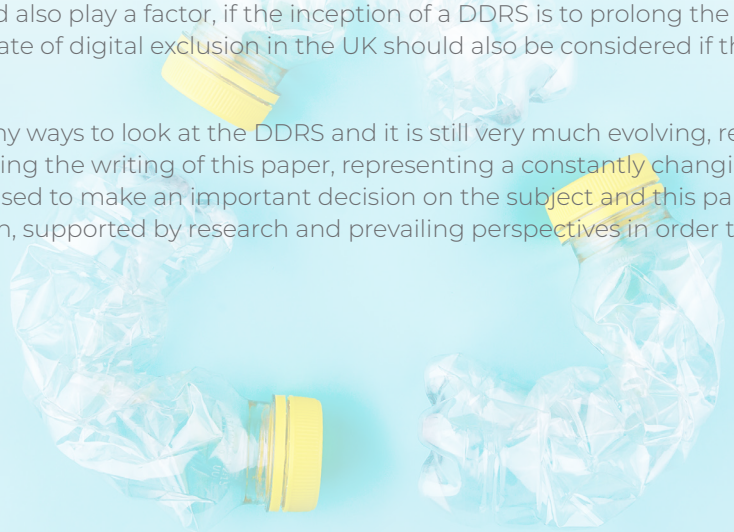
Conclusion

The DDRS is a complex and innovative digital solution for the enhancement of the UK's recycling infrastructure. It can be defined as having four core elements; serialisation, a smartphone application, integration into kerbside recycling and 'on-the-go' infrastructure and the usage of comprehensive IT systems. Although certain elements may be omitted, resulting in hybrid approaches and 'smart' DRS systems. The advantages of the DDRS spring from its usage of serialisation, kerbside recycling infrastructure and sophisticated IT infrastructure. Whilst the disadvantages could be noted as those associated with an over-reliance on emerging technologies and the opportunity costs of not taking the established traditional DRS route.

The trials covered by this report paint a picture of the current standing of the DDRS. The trials have demonstrated the technological ability of the DDRS, such trials often running a full or nearly full DDRS system with little difficulty in the technological aspects of the scheme. Whereas data gathered from the trials have often shown a promising consumer engagement rate, in some cases a high return rate and often a generally positive consumer perception of the trial/DDRS initiatives shows more broadly. Further large-scale trials would be necessary to gather more data and further test the validity of the DDRS through trials inclusive of all the DDRS elements in a context resembling 'real-life.'

With regard to considerations for the context in which a DDRS would enter in the UK, some forthcoming regulation may offer avenues to capitalise on the inception of a DDRS. Whilst Scotland's pending implementation of a traditional DRS may hamper the initiation of a DDRS if such a system is to be perceived to be putting pressure on those within the value chain to adapt to multiple systems within the same region. The recent delays in the initiation of UK policy could also play a factor, if the inception of a DDRS is to prolong the implementation of any pending legislation. The state of digital exclusion in the UK should also be considered if the DDRS is to compound any of its existing effects.

To conclude, there are many ways to look at the DDRS and it is still very much evolving, research and further trials were undertaken even during the writing of this paper, representing a constantly changing landscape. Regardless, much of the UK stands poised to make an important decision on the subject and this paper is intended to serve as a guide to the discussion, supported by research and prevailing perspectives in order to present the existing situation.



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