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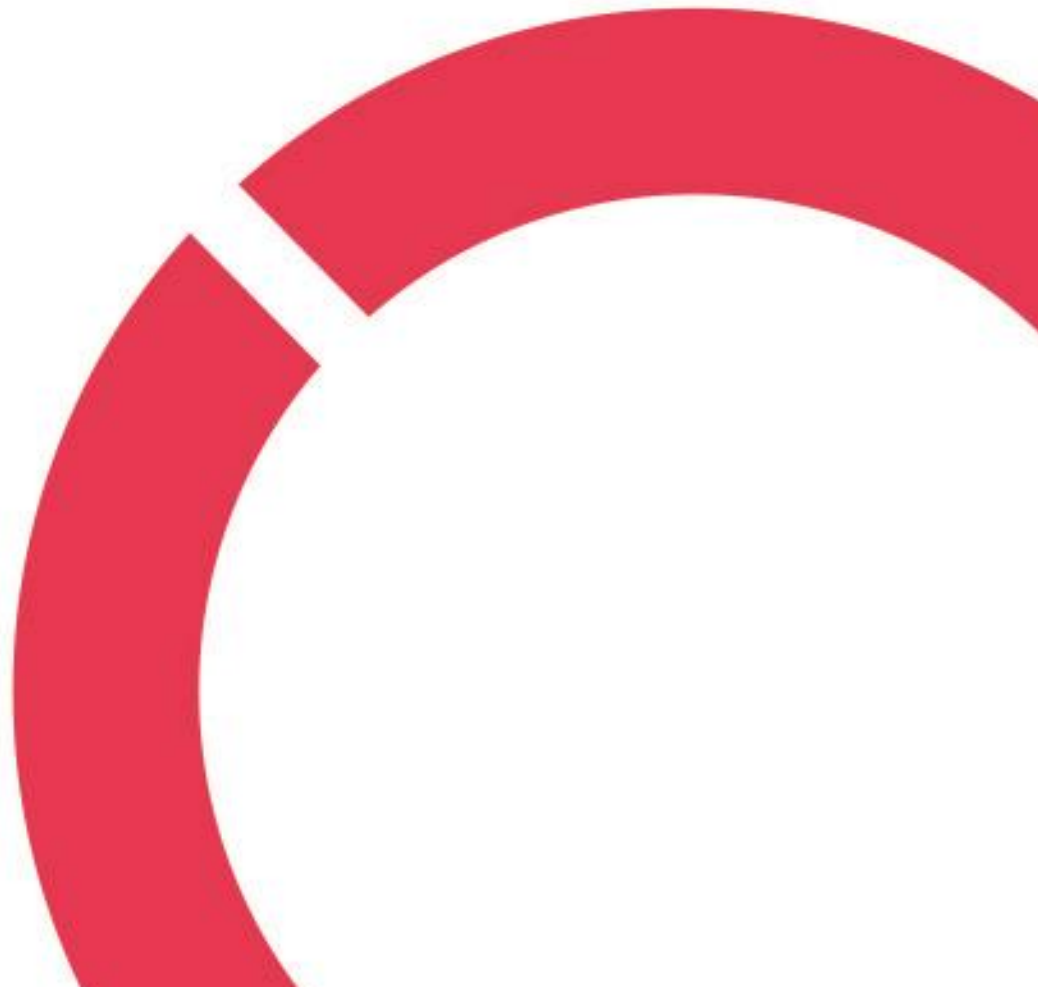
**DIGITALIZATION OF A WASTE MATERIAL INCENTIVE  
PROGRAM: CASE PALPA**

**Thesis**

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**ABSTRACT**

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<p>Palpa is a well-known recycling initiative in Finland. This thesis looked at ways the program can be improved. Although the current program boasts an amazing return rate for cans and bottles, there are few major problems with the program specially with the digital aspect of it. Two examples of the digital technologies this report recommend combining to address these challenges are a special Palpa Wallet and improved RVM capabilities.</p> <p>Data analysis and interviews helped to determine key issues. Although store-specific credits restricted the choices open to consumers for redemption, the most significant outcome of the program was that consumers liked it. Utilizing more simple approaches, certain digital technologies such as QR codes and mobile payment systems can improve user agency, simplify procedures, and reduce waste.</p> <p>If consumers could access a Palpa Wallet, they would have more control over their incentives, which would raise their degree of involvement and enjoyment. Two additional possible results of better data analytics can be more exact teaching efforts and improved resource management. The results of this research emphasized the necessity of preserving the integrity of operations and consumer confidence while at the same time encouraging innovation.</p> <p>The digital transition that is expected will help PALPA maintain excellent return rates while also meeting contemporary technological needs by employing conformance. This guarantees that the program will remain effective in promoting environmentally conscious recycling practices as well as relevant.</p>		

<p><b>Keywords</b> digitalisation, recycling, reverse vending machine, sustainability, technology, waste material</p>
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**ABSTRACT**

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## 1 INTRODUCTION

Palpa Waste material incentive scheme's digitalization increase consumer involvement, in all age groups, refund system efficiency and sustainability. This thesis mainly addresses the recycling system for beverage containers in Finland, under the management of Palpa. Bottle-cans Recycling and its Finnish incentive program have led the country to 90% return rates. (Ecomond, 2024). However, customers still cannot utilize the incentive program outside of participating venues, therefore limiting their options and making the service less handy. Within the framework of this study, it is studied how reverse vending machines can be employed with digital payment methods such as QR codes and mobile wallets so that Palpa can improve data analytics thereby enabling better decision-making, opportunities for partnering or decision-making companies, higher customer engagement and streamlining of consumer life.

Palpa could be able to reach more customers of all ages, enhance our return system, and increase the return frequency by uploading their waste material incentive program online. This thesis mostly centres on Palpa, Finland's manager of the recycling program for beverage containers. The present strategy reduces consumer alternatives and the general user experience as it limits deposit returns to cooperating companies.

This thesis aims to present a digital waste incentive program for Palpa by analyzing system limitations and implementing a QR code-based e-wallet with structured withdrawal and donation options, alongside a data-driven model to enhance user engagement and operational efficiency in Palpa's recycling system.

QR codes and the ability to utilise mobile wallets might help the reverse vending machines presently in use in Finland to be upgraded. Palpa can use these technologies to provide consumers with simple recycling alternatives. Based on the theory, palpa will have access to a lot of analytics data and the integration of digital payment methods will simplify user activities. The conduct of consumers might inspire more focused advertising and better company decisions

depending on better data collecting. Using this information, companies that are both environmentally aware and creative might create strategic alliances among themselves.

This thesis aims to show how one can design the recycling and refund system using digital technology in a manner not only practical but also environmentally friendly. Using RVM technology, data analytics, and customer interaction, Palpa can create an incentive program that not only meets the expectations of individuals who are now recycling but also establishes a global recycling standard.

## 2 COMMISSIONER

In Finland, Palpa is in charge of overseeing the nationwide recycling program including cans and bottles and they have collected and processed 2.2 billion containers, helping to redeem around €350 million in the year 2023 (Palpa, 2024). Currently spread around the nation, there are more than 4,000 reverse vending machines (owned and maintained by the vendors) mostly found in supermarkets (Palpa,2024. With the size of the system, user assessments have highlighted its flaws, especially the inflexible redemption of the store credit process. Given the scale of the system, this is very relevant for Palpa as this case study investigates how they can digitalize the system, make it more user and environment friendly and raise its general efficiency.

Palpa's creative energy and effective operations already make her a significant participant in the Finnish recycling scene. Across Finland, cans are returned at an average rate of 47 per second, plastic bottles at 21 per second, and glass bottles at four per second. Return rates in 2023 totalled 98 percent for aluminium cans (out of 1.48 billion sold), 90 percent for plastic bottles (out of 715 million) and 99 per cent for glass bottles (out of 138 million). On average, every Finn returns 405 items in a year: 263 aluminium cans, 118 plastic bottles and 24 glass bottles. (Palpa, 2024. Users are looking for more flexible and adaptable alternatives as the present system depends on physical redemption at affiliated companies. Palpa will be able to eliminate these obstacles and modify its goods and services to fit the always-shifting social and technical needs, therefore strengthening its offerings and restoring the confidence of its consumers.

Palpa's system's digitisation will make returns simpler to handle and enable the recycling plan to change with customer requirements and technology developments. By use of mobile payments, QR codes, and a Palpa Wallet, the company can reimburse consumers despite of purchasing location.

Digitizing the system will also help Palpa enhance internal operations through technology. Improved data collecting and greater awareness of customer behaviour might help to provide more focused operational changes and better decision-making. By use of this knowledge, one

may simplify logistics, pinpoint regions of highest use, and enable predictive RVM maintenance, therefore enabling a decrease in running costs and the effects on the environment.

### **3 RECYCLING SCHEME AND CURRENT INCENTIVIZED PROGRAM**

Finland's recycling system's great efficiency can be mostly ascribed to the deposit-refund policy, which motivates people to recycle their empty beverage containers. Digitization efforts are essential for the recycling industry. By allowing its customers to get their reimbursements using QR codes or mobile wallets, the recycling company can provide them more freedom with a replacement for the need for paper receipts. Apart from improving program efficacy and recycling rates, they would also obtain insightful data on consumer behaviour resulting from this shift towards digital refunds.

#### **3.1 History of Bottle Recycling**

The concept of recycling – the action of collecting and processing materials for reuse – of bottles, more so glass and plastic, is not new and can be traced back to the earliest civilizations. Over the years, bottle recycling has turned from an activity associated mainly with economic benefits to a practice that has become integral to most sustainability activities worldwide. This is very important in understanding the rise and significance of modern recycling and its technologies.

Recycling in its simplest form began over a century ago when materials were less available, and people had to do their best to use every bit of what they had. Glass bottles were among the earliest items to go for recycling. Usage of glass was prevalent among the ancient people from the Egyptians and the Romans (Lancen, 2023). These civilizations geologically advanced glass-making and basic glass-melting technologies. In short, waste recycling was not in a collection drive but a functional way of extending the use of materials and saving raw materials. Slowly in the nineteenth century and the first decades of the twentieth, glass bottles, previously discarded, started to be returned in larger volumes for refilling. Most of the beverage firms, especially milk dairies and makers of sodas went for this bottle deposit scheme which encouraged customers to

return empty bottles. The returned bottles were cleaned and reused allowing for reduced costs of production and saving of other inputs.

In the last two decades of the 20<sup>th</sup> century, of all the other things that could be made portable, the greatest burden that could be carried seemed to be plastic bottles (Lancen, 2023). Glass was too heavy and brittle for beverage manufacturers, but the plastic was realized to be lighter, tougher, and economical to manufacture than glass, thus, it is quickly embraced by the beverage industry. Yet, if glass has the characteristic to withstand an endless number of recycling processes, which is the retention of the quality of the product, it was different with plastic where the processes of recycling concentrated on plastic products where the distribution of other materials was a problem.

In the 1970s and early 1980s even as concerns over the environmental impact of plastic waste grew, the possibility of recycling plastic bottles hit a technical and economic wall because of the trouble with separating and processing as well as reusing several plastic variations (Lancen, 2023). Notwithstanding, due to societal demand and law, there was a new approach. The innovation of new kinds of bottles made from plastics known as PET (polyethylene terephthalate) hit the market in the 1970s (Lancen, 2023). Recyclable PET bottles did not introduce any pollution and allowed the production of many secondary items including but not limited to, fabrics for carpets, clothes and new containers. This advancement created a foundation for the endeavours of recycling plastic bottles towards the end of the century.

Heading to the end of the 20<sup>th</sup> century and the beginning of the 21<sup>st</sup> century, many countries have incorporated recycling as part of waste management practices. Systems were enhanced such that sophisticated single-stream recycling was put in place such that all bottles and other recyclable materials would be placed inside one bin for pick up. There was also considerable improvement in the equipment used for sorting and processing waste, enabling the collection of more recyclable materials and minimizing their contamination (Lancen, 2023).

Germany, Sweden and other leaders in the European Union adopted advanced deposit return systems and implemented policies favourable to the recycling of bottles. The European Union set

out high ambitions in terms of the percentage of plastic and glass bottles that should be recycled. Likewise, Japan and other countries in Asia also put in place plastic waste recycling measures with very high glass and plastic recovery rates (Lancen, 2023). In as much as these have been achieved, some issues still abound. The global plastic crisis has exposed the weaknesses of existing recycling measures since very few plastic bottles are turned into new products. Investments in biodegradable plastics and finding ways to decrease waste through a circular economy paradigm where materials are used for as long as possible have been on the rise.

The history of bottle recycling illustrates how waste and resource management have changed over time. Simple reuse has evolved into a system that requires government, industry and individual cooperation. New devices and methods of recycling and sustainability will also be necessary to deal with the so-called present issues. The narrative of bottle recycling asserts the necessity of work in progress for the sake of the ecosphere for the benefit of people's descendants.

### **3.2 Finnish bottle and can recycling scheme**

Regarding recycling glass bottles, metal cans and plastic bottles used for drink containers, the Finnish recycling system is well-known for its effectiveness and simplicity, especially the recycling system is praised for its capacity to recycle plastic bottles. The full system in charge of gathering, sorting and recycling beverage containers throughout the country is run by Palpa (Palpa, 2024). Customers who buy a beverage associated with the refund policy must place a little deposit on the container with the beverage and get their money back upon return of the container and this is the way the system runs (Borchard, Zeiss and Recker, 2021). Finland has been a worldwide pioneer in the recycling of containers as this approach gives customers an incentive to return empty containers. Palpa's turnover amounts to about 80 million euros, generated from material sales, and recycling fees and unredeemed deposits (Bogdanov, 2021). The substantial return valued showcased the degree and success of the recycling operation. In the recycling system, RVMs are used to collect the containers, at first the consumer brings the container to an RVM then the container gets dropped into the RVM. The Container bar code gets

scanned and RVM showcases the incentive. A store credit note gets printed and lastly, the consumer buys something to use the credit note or receives cash from the counter in exchange for the credit note. (Chandler and Graham, 2016). The Finnish system aims to gather and recycle almost all the drinking containers that are used but there are certain restrictions concerning this (Majumder, 2022). The most crucial thing in this matter is redeeming a refund. Using store credit notes allows to get the money back at this point, but these credit notes must be used in the same shop where the container was returned. As such, many of the customers are unhappy with the rigidity of the circumstances as they would rather have more flexible ways to get their money back (Kurniawan et al., 2022). The adoption of the Palpa e-wallet to associate the incentive program and digitization of financial transactions is becoming more important (Onur et al., 2024). For example, Norway has put in place more convenient mobile payment methods, has made development in this field and has managed this well because the digital return system there has shortened transaction times by a quarter of a percentage point therefore illustrating how digitalization might result in rises in efficiency (Golush, 2008). Palpa is looking at many alternatives to paper credit notes to fit the changing preferences among consumers.

### **3.3 Waste materials: bottles and cans**

The three main types of beverage containers Finland's recycling system gathers and handles are glass bottles, aluminium cans and plastic bottles which are fundamental to the operation of the circular economy and make up most of the containers Palpa manages (Seyyedi et al., 2024). Plastic bottles are one of the many elements that make up this recycling system because their obvious cyclical character distinguishes them. Once processed old plastic bottles are recycled and then used to produce new ones (Kurniawan et al., 2022). The deposit-refund policy, which motivates customers to return their containers, is one of the factors influencing Finland's quite high percentage of plastic bottle recycling (Borchard, Zeiss and Recker, 2021). Additionally, valuable resources like aluminium cans are used in the recycling operation. The sole benefit of aluminium is that it is recyclable. Hence, it can be recycled endlessly without experiencing any deterioration in its quality. Aluminium can be recycled rather well, for example in 2022, 100% of all cans returned to Palpa were put back into use which emphasizes how quickly the recycling

process works (Bogdanov, 2021). Since one metal can save enough energy to run a computer for a considerable period, recycling aluminium cans is a great way to help lower energy consumption (Onur et al., 2024). Though glass bottles are not used as much as plastic or aluminium bottles, the Finnish recycling program gives the glass bottles great importance and using the collecting and processing of glass bottles, it is guaranteed that these bottles will either be used for other purposes or recycled into fresh glass goods (Majumder, 2022). Like other countries, Finland boasts an astonishingly high glass recycling rate. 99% of all glass bottles returned which find their use in wholly new containers (Palpa, 2023). It is the responsibility of the consumers to make sure Finland's recycling program is successful to ensure its efficacy. Consumer behaviour is mostly driven by ease of use. Hence, any efforts to make products more accessible for customers might lead to higher return rates which would drastically lower the effects drinking containers have on the environment and greatly increase Finland's already outstanding recycling efficiency.

### **3.4 Reverse Vending Machines (RVMs)**

Reverse vending machines or RVMs are the basis of the recycling mechanism in Palpa, which have been placed deliberately to let different people return empty beverage containers and can be seen throughout Finland. Daily processing of cans is handled by the roughly 4,000 RVMs that make up the Finnish network (Bogdanov, 2021). Through automated collecting and sorting of beverage containers, reverse vending machines significantly enhance the recycling process (Chandler and Graham, 2016). RVMs have a useful purpose even if they appear to be simple for the consumer to use. It checks the barcode on the returned container to decide if it qualifies for a refund. The barcode shows if the container is composed of plastic, metal, or glass. Beverage containers' rate of return in Finland has steadily been greater due to the reverse vending machine included in the national recycling system and the RVM system that is presently in use has several flaws even if it is efficient (Onur et al., 2024). One of the most important problems is connected to the usage of paper shop credits. In Finland, cash usage is steadily declining as the country progresses towards becoming a predominantly cashless society. As of recent data, only about 10% of Finns frequently use cash as a payment method (Yle, 2018).

### 3.5 Incentive Programs and Store Credit Notes

Consumers who buy drinks online might pay a deposit to retain their drink until they are ready to return it to a retail value manager, therefore, obtaining their money back. The vast scope of the recycling program caused Palpa to distribute in-store credit notes using more incentive mechanisms. (Palpa, 2023). There can be critical comments on the inflexibility even if it has been successful in raising recycling rates. Shop credit notes are the preferred approach for getting refunds right now; however, they can only be utilized at the same retail location from where the container was returned (Onur et al., 2024). Commuters travelling to a great distance for entertainment, usually bring their beverages with them, but after the trip, they must bring those empty containers back to their home to drop them off at an RVM, which is a hassle. They can drop it at an RVM near their trip destination and they would be forced to buy something or get cash from there. This type of situation can be avoided if there is a more flexible refund policy. Palpa is looking at many digitization approaches in response to the need for more diversity of refund choices. Customers would have more freedom in choices of how they would spend their reimbursements should Palpa switch to a mobile wallet system. Consumers can choose to transfer their refunds to any merchant they like or to save them for use later on. Case studies from abroad show that this adaptability would raise consumer enjoyment levels and also enhance the possibility of container returns (Chandler and Graham, 2016).

While at the same time streamlining the process for consumers, a digital refund system has the opportunity to save running costs related to the printing and processing of paper receipts but there are new costs related to digital solution. Palpa should cut away the requirement for paper receipts, the business would save almost half a million euros yearly (Palpa, 2023). Apart from this, Palpa would have access to a lot of data on consumer behaviour, keeping GDPR in mind and utilizing digital reimbursements, which might help to improve the success of the recycling initiative (Sharma, 2007). This information might be valuable for the complete operation of the recycling system . Last but not the least, in terms of recycling programs, Finland's bottle and can program is the most excellent one available (Seyyedi et al., 2024). Nevertheless, Palpa will have to create new technologies and change with the tastes of its consumers if it wants to be the most

successful recycler in the globe. Using digitization, Palpa enables the optimization of the efficiency of the recycling system, the lowering of operating costs, and the improvement of user comfort.

### **3.6 Importance of Recycling**

Recycling is one of the practices that ensure the environment is sustained, especially in handling both plastic and glass bottles and cans. These products are very crucial in the case of recycling since they help in the conservation of resources, minimizing pollution and addressing the ever-increasing challenge of waste management . To expound it further, when it comes to the production of plastic water bottles, the materials that read petrol chemical or more typically known as ‘oil-based’ resources (Lancen, 2023). This is because the oil resource is limited and is also harmful to the environment due to quarrying and further refining that takes place. The recycling of plastic water bottles helps to alleviate the demand for new materials which in turn reduces energy consumption and carbon emissions. This way, because already available plastic is being used, the adverse effects that can be caused by drilling and making new plastics are avoided, that is, an energy that is used to produce gases that can be detrimental to the environment. Other methods for lessening environmental harm include recycling or throwing away glass bottles as well. Recyclable virtually without degradation, glass and cans can be reused as raw material without any loss in quality (DECCW, 2010).

Apart from the ecological consequences, there is an economic effect of recycling bottles. The recycling sector generates money and employs the activities of collection, sorting and processing of waste material for recycling. Recycling drives usually demand Bill More Community but create jobs devoid of expensive wire cage renting because it will help lower the costs of maintaining landfills. Now, the production of such materials is rarely higher than that of virgin materials . For example, to use less energy, water and raw materials in construction production processes that involve the use of recycled glass and plastic in comparison to when such new products are made. This makes these zero-waste strategies more appealing to consumers as the prices of the products created from such strategies lower making the economies grow faster

(Pascual, 2019, pp.67–70). There are economic benefits of recycling bottles in the aspect of circular economy which strives to elongate the lifecycle of goods and raw materials reducing the occurrences of wastage while optimizing the efficiency of resources. This economic approach is crucial for the achievement of eco-friendly development and optimizes creativity in the approach of designing and utilizing the products.

At a very individual level, among many other things, recycling glass bottles is arguably the easiest thing a person can do for the environment. Even minor alterations as far as every day, routine practices are concerned, such as using this non-disposable one rather than unnecessary single-use plastic bottles, including properly sorting the waste, have a great cumulative effect. There are also environmental benefits associated with reducing the number of plastic bottles and other disposables used which need to be recycled. Recycled plastics do not have to be produced, which consumes a lot of energy and is dependent on the use of fossil fuels. As the reduction in the production of new plastic helps cut down emissions, this helps in preventing the adverse effects of climate change (Lancen, 2023). It is important to highlight that the cost of producing new plastics is much higher than recycled plastic regarding greenhouse emissions. A report published by the EPA reveals that one ton of plastic uses up to 5774 kWh of energy and produces roughly 1.4 tons of carbon dioxide equivalent emissions in its production (Pascual, 2019, pp.67–70). Nevertheless, it has been noted that considering the levels of plastic produced and consumed all over the world, even small increases in this activity can lead to extremely positive outcomes for the environment.

Recycling glass readily available from bottles and jars, unlike plastic, is equally effective if not more. Reusing glass includes melting it down and forming it into new containers or products. This process can be repeated without any constraints. This system leads to reduced raw material collection, in this case, sand which is rather expensive to mine and is becoming a faster resource. In addition to this, there is disposal of waste screens in a landfill hence controlling the amount of glass waste, and that of raw materials mining to transportation scarcely health impacts due to pollution (DECCW, 2010). There is also the energy-saving part that should be noted because the recycled glass does not need to be heated to as high combustion gases as the sand, soda ash and

limestone which are used to make new glass containers. Here, the fuel combusted is less, releasing less emissions, and thus a smaller ecological footprint.

Understanding interrelations and their influences within the bottled beverage industry calls for improved decision support systems and methodologies. Additionally, bottle reclamation is becoming more relevant owing to changing societal attitudes towards environmental sustainability. Novel sorting machines capable of recognizing various grades of plastic, glass manipulating robotics, and chemical recycling, which reduces plastics to their building blocks for upward utilization, are revolutionizing the sector (Pascual, 2019, pp.67–70). Being more optimistic about the prospects of such technologies includes increased rates of recycling as well as more materials being able to be potentially recycled. For example, chemical recycling is capable of processing complex plastic mixtures otherwise impossible to recycle so every single-use plastic bottle may find its way back into the recycling chain.

## **4 INCENTIVE PROGRAM 2.0**

To reach the objective of overcoming the technological obstacles that they encounter, constant development in machine technology is essential. Future development of technology used in Palpa's return system has a great potential for integration of mobile wallets with its recycling mechanism. The future of the recycling system in Finland will be greatly impacted by the integration of mobile wallets and transactions in real-time, which is expected to be an essential component of Palpa's ongoing technological upgrading expenditure.

### **4.1 RVM technology**

A RVM is a modern technology, which is designed to promote recycling among users by providing them with some rewards for giving up used bottles or cans or any waste items. The main aim of RVM technology is to mechanize the collection and sorting of the used materials, which is convenient for the consumers, and at the same time encourages them to be responsible for the environment. Usually, this equipment is placed in areas with a high foot host nation like shopping malls, schools or bus stops where individuals can deposit used bottles, cans, and other containers. As an added motivation and to promote recycling efforts, the users receive in return for the goods they have brought back monetary values, discounts or loyalty points among others.

From the consumer point of view the way RVMs work is quite simple. A person inserts a bottle or can into the machine's input. The device employs sensors to determine the material of the container (plastic, glass, aluminium) and scans a code on the container to check if it could be accepted for recycling. After that, the device begins to sort and compact the recyclables, holding the compressed plastics and metals until they are picked up for recycling (Brusnahan, 2019). In addition, the RVM is often able to screen for defects (e.g. whether the bottle is empty) and verify that the received subject fit particular recycling requirements. RVM technology is primarily effective in managing waste. It reduces littering by giving easy access place to people to recyclables (Borchard, Zeiss and Recker, 2021). Furthermore, it aids in the organising which

allows the recycling centers to easily fetch the required materials of the different varieties. The system can explain materials for example cans and bottles in terms of Pet, HDPE or aluminium materials and age ready for recycling without any wasteful measures. This curtails the chances of contamination, which sadly happens in recycling practices that make use of various materials in a single collection as the majority of recycled products made from harmful materials.

RVM technology is of great assistance in the attainment of the circular economy. It does so by encouraging consumers to participate in buy-back schemes for empty beverage containers thereby helping to recycle materials back into manufacturing processes. Cleaned and refilled, or reconstituted into new products, the used bottles and such materials do not have to waste so much of the primary raw materials and resources. This is effective in protecting the environment by reducing the use of available resources, energy and carbon footprints.

RVMs possess a key advantage in that they can provide the user with a reward that will induce more people to join a recycling effort. Deposit return schemes in the form of reverse vending machines have been designated to most of the countries or regions containing deposit refund returns. For example, Germany, Norway, Sweden and numerous other nations have been incorporating RVMs into successful bottle-return schemes where a user submits an empty bottle and is compensated a certain amount of money in exchange for that empty container to which he/she gets a refund (Borchard, Zeiss and Recker, 2021). As a result, the recycling rates in these areas have increased substantially.

RVMs are also getting advanced and coming with different additional features, including screens that show the users the environmental impact of their actions, for example, how much CO<sub>2</sub> emissions have been saved or energy saved by the user. Data from RVMs for example can also help to monitor the recycling behaviour in a given area or region and help in waste management. Some sophisticated systems for example in Sweden even support mobile apps that allow users to log their recycling statistics and work for rewards or coupons.

It can be stated that the development of RVM technology is a great contribution to waste management and recycling techniques as well. Because they come with automation,

convenience, and incentives, RVMs inspire one to participate in recycling programmes at a greater scale, mitigate litter, save on resources, and encourage sustainability at best. With the advancement of technology, it will even be more vital in achieving the goal of a circular economy with minimal waste and prolonged use of materials.

## **4.2 RVM shortcomings**

RVMs are vital components of Palpa's recycling program. Notwithstanding this, technological problems have become a major obstacle to the general efficiency of the system independent of their relative importance. Over its network, Palpa has recorded a lot of errors. These mistakes not only annoy customers but also compromise the dependability of the system. Customers find these mistakes frustrating (Borchard, Zeiss and Recker, 2021). RVM issues caused Palpa and its customers considerable financial losses. In general, Palpa processes 360 million euros a year in bottle deposit money (Bogdanov, 2021). The many technical problems resulted in more frequent machine needs for maintenance (Golush, 2008). This resulted in more running costs as the recycling program did not operate as it ought to have. This resulted in more running costs for the RVM owner as the recycling program did not operate as it ought to have. Using quick response codes for refunds might help to solve these technological difficulties in place of paper receipts. Denmark was able to lower the number of transaction failures by adopting QR-based reimbursements (Onur et al., 2024). If Palpa changed their RVMs to include QR codes, the operating expenses and customer experience might be much enhanced. This would lead to a significant drop in mistake count and increase system dependability (Sharma, 2007).

## **4.3 RVM Technology: Synopsis of Its Evolution**

One flaw of the currently used RVMs is that they only provide paper receipts and store credit (Zhou et al., 2021). This not only aggravates the technological challenges customers encounter but also lessens their access to refund policies. Real-time transaction systems and mobile wallet integration allow consumers to interact with Palpa's recycling program in a manner that can

change greatly (Majumder, 2022). Allowing consumers to acquire quick refunds using mobile wallets, therefore, eliminates the requirement for users to have printed receipts and it can also reduce the possibility of technological failures. A study shows that Germany's national RVM network likewise made similar changes and included technological failures (Sitra, 2019). Palpa helps its customers benefit from the accelerated refund procedure made feasible by these RVM technological advancements. Across Finland, cans are returned at an average rate of 44 per second, plastic bottles at 21 per second, and glass bottles at four per second (Bogdanov, 2021). Reducing the time spent on transactions and doing away with the requirement for paper receipts might help the business save maintenance costs and increase the success of the recycling initiative (Seyyedi et al., 2024).

#### **4.4 Mobile wallets in the system**

There is a possibility of a Mobile wallet for general acceptance in Finland. An easy and quick substitute for conventional paper-based shop credits is mobile wallets. This is achieved by allowing users to access their recycling reimbursements on cell phones, or other mobile devices. A study shows the possible advantages of integrating mobile wallets into a recycling setting (Onur et al., 2024). Finnish residents returned more than two billion bottles and cans in 2020 (Bogdanov, 2021). Once the container was returned, customers valued the ease of having their reimbursements sent straight to their mobile wallets instead of being limited spending the money at the shop where it was returned. Given this success, Palpa could be able to forecast such results in Finland should they build a return system grounded on mobile wallets.

#### **4.5 QR codes refund transfer**

Quick response codes are a fresh, easy-to-use, rather successful method of merging internet payment systems with in-person transactions. By integrating QR codes into its RVM system, palpa lowers the need for paper receipts. This allows customers to avoid paper receipts by having reimbursements straight into their e-wallets. This technology has been effectively used in other

nations, which suggests that it can simplify consumer refund policies and raise their degree of satisfaction. For instance, using QR codes for refund transfers in Denmark produced an eighty per cent drop in the number of paper receipts and twenty seconds less time needed for each user to complete a transaction. (Majumder, 2022). More people could recycle their containers in a shorter time since RVM processing took less time. Apart from helping the environment, the recycling initiative greatly reduced the generation of paper waste utilizing the lowered consumption of paper receipts. Palpa could be able to gain advantages by using QR code technology (Borchard, Zeiss and Recker, 2021). Furthermore, because customers can transfer their money back to any bank account or mobile wallet of their choosing when they utilize QR codes, they have more options (Sitra, 2019). This provides them with greater freedom which would be a good strategy for the recycling program overall.

#### **4.6 Improving the Analytics System**

Changing to a digital incentive system offers Palpa a chance to increase its performance in the area of data analytics. With the current system, Palpa does not get any information other than the container itself. If Palpa were to integrate its RVM network into mobile wallet systems and QR code technology, it would be able to collect more in-depth information on the tastes and habits of its clients (Onur et al., 2024). Real-time data on consumer behaviour made possible by digital refunds is among their most important advantages. Using mobile wallet refunds, for instance, data on recycling rates at the regional level was acquired in Norway, which led to more effective placement of RVMs. This was carried out to raise recycling rates. The Norwegian recycling authority improved machine distribution by maximizing machine locations depending on customer return data. Palpa's RVM network can be strengthened by adopting data-driven tactics to eliminate downtime that is caused by abuse or underutilization and optimize machine placement in locations that have the greatest demand (Chandler and Graham, 2016). It is also likely that the data created by digital transactions can be of aid in the process of making strategic choices and predicting trends in the recycling business. It is feasible that Palpa, for example, might change its logistics operations in reaction to data on consumer behaviour that suggests which regions are likely to witness an increase in the number of container returns (Zhou et al.,

2021). By boosting the performance of its recycling network through the use of predictive analytics such as these, Palpa can be able to reduce some of its operating expenses (Sitra, 2019). With better data analytics, Palpa would have a higher degree of control over the allocation of resources and the forecasting of demand, which would result in the business saving an estimated two hundred thousand euros annually. Not only can the information collected via digital refunds be employed to enhance operations, but it might also be put to use in the creation of more targeted methods for communicating with clients. (Majumder, 2022). If Palpa were to conduct concentrated marketing efforts to less likely customer groupings that it uncovered from return pattern analysis, it might be able to raise the number of individuals who engage in the recycling program (Kurniawan et al., 2022). It has been established that data-driven marketing operations that employ this strategy have been effective in other nations, leading to substantially greater container return rates (Onur et al., 2024). By exploiting the possibilities given by data analytics, Palpa can alter its recycling program to suit the ever-evolving needs of its customers in Finland.

## 5 RESEARCH METHODOLOGY

This case study used a qualitative research approach to analyze Palpa's incentive program, a part of their recycling system and the possible influence of digitalization on the incentive program of the organization. Primary research approaches for gathering main data included interviewing Palpa consumers, employees, and other relevant individuals. Purposive sampling was used to get diverse types of data for qualitative research to get a better understanding of the issue.

Qualitative research investigates peoples' behaviour, feelings, and experiences in the absence of numerical data (Kruger and Mitchell, 2022, pp.45–49). It seeks to comprehend the more complicated aspects of research by asking the why and how questions that concern decision-making, behaviours and interactions of people. They include and are not limited to, interviews, focus groups, observations and content analysis, which are the qualitative research methods available. This kind of research is mainly qualitative and tends to produce data in word form, images or descriptions of something rather than measurement of anything (Kruger and Mitchell, 2022, pp.45–49). The findings are very rich and full of details enabling the research to go on extensive research on issues or items. This is useful in many fields such as geography, psychology, anthropology and business, all of which study human interaction or society.

Quantitative research, as its name suggests, is the research methodology that involves the collection and analysis of numerical data in a more organized fashion to detect and indicate patterns, relationships or trends. It makes use of statistical, mathematical or computational techniques to interpret the results and usually employs strict shells of data such as sampling, surveys, questionnaires, and even experiments. This research approach involves exploratory research; determination of measurable variables as well as seeking to present scientific evidence that is objective and replicable across the general population. In this instance, this paradigm is often evident in the soft sciences such as physics, biology, chemistry and economics where there is a necessity for unit dynamics (Kruger and Mitchell, 2022, pp.45–49). While both qualitative and quantitative research tasks aim at solving a problem, the two differ in methods and results; qualitative research tries to comprehend ideas and feelings while quantitative research attempts

to count and analyze them in numerical form. These two approaches have their advantages; for instance, qualitative research allows for depth and context while quantitative research gives reliability and magnitude. Commonly, researchers combine the two strategies to form a mixed-method approach to provide a holistic explanation of a research issue taking advantage of both strategies.

This research however, was largely focused on getting comments on refund policies, including those based on QR codes and those integrating mobile wallets. Interviewing Palpa employees was highly advised to help one better grasp the operational difficulties the RVM system is now facing as well as the possible advantages of digitizing the refund process. Data was collected through interviews and later converted into transcribed files for better analysis. Case studies from nations that have effectively used QR codes and mobile wallet reimbursements augmented the central research on digitization in recycling initiatives and a compilation of secondary data was included which was taken from the current research on the topic.

This methodology made it possible to investigate the present incentive system, using data from Palpa's annual reports, financial accounts, and operational records as well as interviews to ascertain its efficiency and point out areas in which it can be improved. The main goals of this study were to assess the possible advantages of digitalization, the difficulties Palpa's RVM network has experienced due to technical issues, and the effect of technology development on consumer behaviour and the effectiveness with which operations were conducted.

## 6 DATA ANALYSIS

Eight participants of the Palpa incentive program were interviewed to investigate how digitization can enhance operations and consumer involvement in Finland's RVM system. The investigation revealed five primary areas that would assist in clarifying the benefits and drawbacks of digital technology as well as Palpa's working mechanisms. Utilizing this study, significant concerns are highlighted, and background data is provided for the digitisation of PALPA's incentive program, therefore opening the path for further investigation and intervention. With the correct objectives and actions, PALPA can maintain and maybe expand its position as the top program for recycling and rewarding incentives in Finland and worldwide.

### 6.1 Customer Experience and Engagement

Three participants believe that PALPA is a good incentive program keeping people engaged in environmental sustainability. Many consumers are satisfied, hence the present approach which largely relies on RVMs to return empty containers works enough and one of the respondents said that by mandating refunds, the legal system helps customers to interact with businesses.

Five of the respondents felt that despite high returns, the incentive scheme failed to keep consumers motivated beyond the initial purchase. Although they do not want to assist with or contribute to neighbourhood gatherings, those who return containers frequently want their expenses returned. Another respondent who agreed with the remark added that individuals are less inclined to remain engaging or donating to charity when the transient character of the trade is under-emphasis on obtaining their money.

One concept that kept resurfacing was that digitalisation would improve consumer experiences. QR codes and smart wallets should simplify shopping. Based on the responses, digitising records and an electronic payment system might help to better interact with consumers by facilitating the return of deposits. One interviewee discussed a test project in Denmark aiming to enhance the

customer experience by reducing the thirty-second transaction completion times, therefore improving the transaction times.

Digital solutions could not lead consumers to donate more to charity after they are implemented as they are still preoccupied with the present bargain. Though it might help things operate more efficiently, digital technology should also consider consumer demands.

## **6.2 Operational Efficiency**

Four of the respondents had positive opinions on the performance of RVMs and said they had few concerns about their performance throughout the last 10 years. They discussed the everyday need to routinely clean and fix machinery to maintain their proper operation. However, two respondents were aware of the pragmatic concerns, particularly on the maintenance of instruments to prevent difficulties utilizing excellent conditions. Two respondents expressed dislike of the maintenance rather than discussing issues with the devices.

Five respondents believe that using digital technology might help processes go more smoothly. IoT sensors placed in RVMs may monitor equipment in real-time, issue warnings for predictive maintenance, and assist with better planning maintenance. These digital technologies would allow issues to be discovered before they became major ones, therefore ensuring increased dependability in operations.

Although the RVM technology appealed to the stakeholders, they also recognised potential value in QR codes and mobile payments. One of the interviewees said that ‘the technology enabling QR codes for RVMs would enable users to cash in their savings online, therefore eliminating the need for paper documentation.’

Though there were advantages, four doubted whether the system was ready to use such advanced technologies. Six respondents underlined that the gradual introduction of technology could help consumers avoid being confused but two respondents stressed the need to train consumers and

retailers as well as maintain open lines of contact throughout the full process when new technology replaces traditional methods of operation.

Big subjects of discussion all through were privacy and data protection. Given that digital solutions potentially expose personally identifiable data, many were concerned about how data was gathered and utilised. Respondents felt that it was essential to make explicit data management and usage restrictions required.

### **6.3 Data Utilization and Insights**

Three Participants said that digitizing data can simplify data collecting and analysis. One respondent stated that ‘with the correct digital infrastructure, PALPA could learn a lot about the behaviours of its clients.’ This type of knowledge might be useful for education, marketing, and management as well.

The interviews revealed that privacy protection and data sharing are major issues. Three respondents were concerned that their data would be exploited in the framework of analytics and targeted marketing while distributing consumers' personal information, therefore violating their privacy. Using data for corporate purposes while nevertheless safeguarding consumers' privacy is difficult.

Data-driven marketing, according to these individuals, might also benefit younger generations—who might not recycle as much as more seasoned ones. PALPA may attempt to contact people less inclined to return packages if it knew more about the likes and dislikes and habits of its consumers.

### **6.4 Future Perspectives on Sustainability**

Though it will always be difficult to attract those who weren't already involved to join, five interviewers were hopeful about the long-term effectiveness of the PALPA incentive program. A return rate of more than 97% is, everyone agreed, a wonderful achievement. The few absent percentage points, however, might indicate that consumers have firmly rooted, difficult-to-modify purchasing behaviour.

Four people, who participated in the interviews mentioned that the community should become engaged and individuals should keep learning if more people are expected to recycle. The great majority of individuals felt that the next generation should oversee environmental initiatives. Many of the people said that school recycling initiatives had increased students' enthusiasm to recycle and taught more environmental knowledge to them.

## 7 DISCUSSIONS

The interview results shed enormous light on consumer education, service delivery, technology, data as a resource, and considerations for the sustainability of PALPA's recycling scheme from other angles. The chapter examines these findings from different angled perspectives concerning customer experience, operational efficiency, technology, information protection and long-run viability.

In the remarks concerning PALPA's initiative, the program's success is demonstrated by findings. This shows that the consumers would easily be swayed by the financial rewards for behaviours which the program seeks to encourage – that of return. This return rate indicates an encouraging first interaction by the consumers which is in great part due to the point of return designed in the form of RVMs that offer benefits. One of the interviewees observed that making refunds obligatory by law is one way of enhancing the relationship between consumers and businesses making recycling a way of life.

Nonetheless, the involvement seems to be more of a give-and-take relationship whereby many of the participants confessed that the financial incentive was not enough to prompt a strong long-term engagement. Five interviewees mentioned that while those who participate have the intention of getting their money back, it does not lead to their active participation in environmental stewardship or any other social cause. This implies that the current incentive structure while working on bringing back investments, lacks the psychological and social elements that could encourage deeper environmental awareness and participation in the community.

Another issue that guided the consumers' focus was the issue of digitization. Detractors asserted that such solutions as QR codes and smart wallets would assist in minimizing the troubles undergone during the process of product return. The easily comprehensible Danish test project, which tried to address the issue of transaction reduction duration, is important in this case because it emphasizes reducing the turnaround time and enhancing overall satisfaction. Still,

there is a rider: that is, the inclusion of more facilities will lead to operational effectiveness but may not alter the present habits of the patrons to give offerings or participate in other activities without monetary benefits as the existing driving force is self-interest in financial paybacks.

Partners underlined in the conclusion that PALPA must be ready to adjust to government regulations and the often-shifting state of the market. The European Union is giving sustainability and activities connected to cycle economies more attention. PALPA must so be prepared to adapt to meet the new legal criteria that is to come. Digital technology might support communication as well as the completion of tasks. The interviewees asking for the thesis say PALPA's incentive system runs things smoothly and has excellent return rates. Digitising procedures has both positive and negative consequences, hence one should exercise great caution. To make PALPA's incentive program more efficient and adaptable, the organisation must give customer interaction, operational efficiency, technological integration, data utilisation, and sustainable practices a top priority. PALPA is headed towards a digital future if recycling is to endure and if people are to become engaged in their community.

This discussion has made clear the need for strategic planning and maintaining contacts with colleagues. Having data from a digital incentive program can be beneficial. Data on consumer behaviour might help public awareness campaigns aiming at failing groups like young people living in cities—benefits. These kinds of tailored approaches are required to either maintain or even increase the return rate by itself. One should monitor legislation, controlling data collection and safeguarding privacy to prevent moral and legal issues.

The degree to which PALPA balances theory and reality will determine its future distance. On the other side, as the high return rate indicates, digitisation may make consumers more interested and assist the system to survive longer. Going digital would help the program to remain current and provide PALPA and its partners with a lot of information they could use to make strategic choices, streamline operations, and increase public confidence.

In the last ten years, survey participants have mostly held a positive opinion about RVMs, with many praising their stability. Minimizing maintenance, however, was seen as an obstacle by a

few, and two of the interviewees expressed their dissatisfaction with maintenance rather than any concerns about the equipment. In this regard, this indicates that RVMs are operationally acceptable but the incessant cleaning and maintenance associated with them is a load that may have adverse effects with regards to the usage of the machines in the long run.

Applying sensors capable of monitoring the status of the machine in real time enables predictive maintenance thereby improving machine reliability and reducing down time. Such would not only facilitate the normal functioning of the systems but also ensure that expensive operational halts are dealt with beforehand in case of warning signs. The thought of utilizing IoT does not come as a surprise as it has been observed in other industries which are moving towards the smart systems approach to improve their processes and reduce manual intervention.

However, respondents appeared positive towards technological improvements such as QR codes and mobile payment. They were, however, doubtful of the level of readiness to embrace these changes. Findings suggest that the system could accommodate such changes citing the challenge of the unpleasant consequences of change. This underscores the need for a gradual approach which contains sufficient education and notification of both consumers and retailers to avoid chaos and facilitate easy change. In the absence of proper measures, there is a possibility of disenfranchising those users who cannot or do not want to adapt to the new technologies.

Also, issues of data privacy and protection were quite relevant. The interviewees spoke about the ambiguity of the risks of exposure to personal data versus the benefits of using digital solutions. They also emphasized that the policy on collection, processing and retention of consumers' data should be well enforced to protect the consumers' rights as well as management of the data. There was an emphasis on being transparent regarding how the data will be used, which shows how much society has created an attitude towards digital ethics that the trust of consumers is based on data collection, storage and usage practice.

There is ample opportunity to enhance this aspect since three respondents emphasized that there is a sound logic inherent in the development of a digital framework that seeks to understand consumers better. Such understanding could enhance strategic educational initiatives, marketing

operations, and program administration. Since PALPA has the advantage of knowing what consumers want and how they behave, it is possible to alter PALPA's strategy, therefore increasing participation by subpopulating incentives to different age groups. To paraphrase, privacy concerns carry many anxieties such as how analytics and targeted marketing would use them against the consumers where the information is disregarded.

This is part of a greater societal concern that entails data-driven measures in undertaking business operations as well as the consumers' right to privacy. The difficulty comes with ensuring that data is used for moral purposes without violating the rights of an individual, hence making sure that all the data strategies are ethical and transparent.

Client involvement might be increased via digitalism. If Palpa has simple, technologically advanced features and quick access, it might appeal to tech-savvy millennials and keep dedicated elder clients. Users of digital payment systems have more options, more safety, and easier access to refunds. Convenience helps one increase client loyalty to environmental criteria and return policies.

The results point to both some achievements and some constraints in the implementation of the recycling incentive program within PALPA. Where financial motivators in RVM systems elicit heavy uptake, they do not enhance consumer engagement and participation within the community over the long run. There have been a few successful practices in operations, however, the full advantages of the digital and IoT aspects have not yet been experienced in terms of maintenance and user experience. The gradual and careful application of new technology indicates the importance of the transformation strategy being well articulated and implemented in phases to protect the privacy of the customers. To maintain the gains searching for strategies that will educate and involve the communities that will be more pro-environment active should come first.

## 8 CONCLUSIONS

The Deposit Refund System (DRS) in Finland, operated by PALPA (the Finnish organization responsible for the beverage containers), is viewed as one of the strongest environmental marketing concepts in the world. This approach helps to transform bottle or can usage into recycling through monetary incentives and is an important reason behind Finland's high recycling rates and environmental conservation. This model is very good but has its demerits that come in the way of fully embracing the emerging technological wave. This thesis identifies these limitations and argues that digital extensions could propel PALPA into the recycling-driven future of easiness, more environmental friendliness and customer contentment.

Every other system in practice has a feature whereby consumers retrieve their deposits after returning the empty bottles and cans to some collection agents. This physical feature of the system although it is sociable and simple has its disadvantages in that it does not encourage recycling much. Curbing the returns to particular places limits the alternatives available to consumers and may even discourage some from participating if they are not comfortable with those places, or even worse, those who are used to online services. The main advantage of such turnaround is the introduction of advanced technologies into the system through the use of, for example, a QR code and payment using a mobile phone.

The main benefit of transforming the DRS into a modern system is in the reduction of the amount of paper used and the easy management of the DRS. A QR code-based system will do away with the use of paper receipts which are difficult to recycle, thus providing a more eco-friendly solution which is in line with that of Finland in which there is little aim of wastage. The experience of introducing QR codes as a recycling initiative in Denmark is a useful lesson for Finland. In these ways, PALPA would be able to resolve the existing constraints and also minimize the related expenses while enhancing the ease of use for its users. In Denmark, for example, users take a picture of the code for the payment to be refunded into the users' e-wallets or to clients' accounts. This approach has illustrated the use of an appropriate user engagement strategy in modern logistics with a simplified transport-oriented infrastructure. Sadly, these

technologies have many advantages, but they also have some drawbacks, especially regarding information security and trust towards its users.

To keep the members of society's confidence towards the DRS of Finland over this period, PALPA needs to facilitate awareness campaigns and also ensure that the systems will be user-friendly and secure. There has to be assurance given to the users that there will be no unlawful access or breach of their private information. To build trust and motivate users to embrace the services provided, it is important to observe the data protection laws and put in place strong information security measures.

In addition, the simplicity of interacting with the envisioned platform is crucial in any digital transition. New technologies should be designed in a manner that does not put off the current users, especially those who are not necessarily tech-savvy. For instance, an application designed like the 'Palpa Wallet' app would go a long way in helping this cause. This e-wallet would enable users to manage their deposits effectively; they would be able to withdraw their deposits with ease as well as introduce innovative elements such as reminders or gaming aspects aimed at enhancing active recycling behaviours among its users. Such a system would make the process of recycling easier, interesting, fun, and broadening its appeal to other users including the young generation who are proficient in technology and the older generation who may require a dummy-proof system.

Geolocated solutions and applications like the Palpa Wallet would support PALPA's resolve to optimize its efforts in modern responsible recycling strategies as well as fit in with the ongoing technological revolution. Digital payment and QR code integration would modernize and digitize the entire recycling transactions, which are more than likely to gain more appreciation in the modern world characterized by time and technology. Furthermore, it could showcase Finland's recycling model as the best practice to be emulated by other countries wishing to improve on their environmental initiatives. By showing that it is possible to be advanced in technology while protecting the environment, PALPA will ensure its leadership in the recycling business across the world.

PALPA needs to articulate its goals and execute its strategies if this vision is to materialize. This entails not only advancing the present facilities to sustain digital advancements but also educating the users and creating awareness of the system to foster its adoption. Awareness campaigns should focus on the proponents of digital ecology recycling through enhanced convenience, speedy refund processing, and ultimately a more positive impact in terms of reduction of paper consumption. The introduction of technology in the DRS proposed by PALPA such as QR code payments built into an application such as Palpa Wallet will change the recycling in Finland for the better. Such a transfer would upgrade the level of consumer participation, shrink running costs, and fortify Finland as the most environmentally sustainable nation. By tackling data security issues and ensuring user-friendly designs, PALPA will be able to achieve these advancements to the system without compromising on the current participation levels. The right mix of technologies, confidence, and clear information to the people will also ensure that Finland's recycling program remains effective, flexible and environmentally friendly for many years to come.

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