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Technology Evaluation and Commercialization Report

SMART TROLLEY

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INTRODUCTION

This report explores and demonstrates how the TEC algorithm model was used in evaluation of a business opportunity from a generated technology idea proposed for commercialisation purposes [1]. The idea generation was conducted using the double diamond method in guiding the team towards identifying a technological idea for this project. There are four fundamental techniques within the double diamond method known as Ideation, Requirements, Iterative Design and Idea Implementation [2]. These techniques were utilised by the team to implement a great technology concept which will be targeted towards all the big UK retail stores. The double diamond method aided the team in developing many ideas to narrow it down to the Smart Trolley idea based on a feedback from a focused group within the team. A precise idea came up from the ideas generation list which was chosen for this project.

This document discussed the selection of the Smart Trolley idea through the process of using an algorithm to evaluate the unique business advantages compared to its disadvantages. To come out with creative and innovative ideas, the team was split into two sub teams to generate ideas. Each sub team was responsible to produce ideas which was later managed by verifying with the requirements set for this project. As a team, all ideas were exploited and explored carefully to fit the scope of implementing a technology that is useful in the world of business.

The Smart Trolley idea stood out from many ideas presented by the team based on how the idea would be developed into an interesting technology product which is convenient, easy to use and efficient, including it being an add-on service for the existing self-checkout system. As the concept was based on technology, it was important to get the insight of consumers for which the idea was designed. The purpose for this was to analyse the role of assumptions, perceptions and expectations from the stores and its daily customers towards the proposed Smart Trolley idea for UK supermarket outlets and perhaps to other European countries. The team had a great response from a targeted major retail stores such as Tesco, Asda and Sainsbury after a focused group from the team had made contact.

The Smart Trolley idea is based on the most popular automated self-checkout system in most of UK retail stores. The concept is designed into a smaller version of the automated self-checkout system on a shopping trolley with a user interface screen which allows customers to make payment for items scanned and placed in the trolley before leaving the entrance of the store. This is to release pressure at the tills during peak hours. The Smart Trolley comes with all the traditional services including scanning an item to check for price and details, also there are other additional features that will be included in the design such as locating an item in the store by typing in the item's name in the search field on the user interface screen which will automatically show the item's location in the store. The Smart Trolley is designed with security measures to prevent it being wheeled out from the store's premises and also to protect customer's card details as it is designed to accept only card payment for items bought in the store.

AIMS AND OBJECTIVES

The fundamental focus of this project is to express the following aims and objectives, while also using a clear distinctive approach which will elevate this project from start to finish.

Aim

To apply innovation knowledge and skills required in entrepreneurship. This is to identify technological project idea that will be evaluated for its business potential by using the TEC algorithm.

Objectives

- Preparation and Planning - Establish how to use tools, methods and processes to generate a technological idea which can be assess for commercial purposes within a time frame.
- Requirement Analysis - To analyse the project requirements which includes generation and selection of product ideas, definition and value proposition of product, market research and assessment includes, function of product concepts and strategy of commercial viability.
- Product Design and Architecture - Based on the project requirements, technologically-oriented design will be adopted in designing the system architecture of the product including modules of the system.
- Implementation of Design - To ensure the product is implemented with the sense of promoting business opportunity by using the TEC algorithm.
- Results - To develop a commercialisation strategy in making this project a potential business by producing a business plan.

METHODOLOGY

To produce an uplifting piece of work, the project went through different strategic stages to outline a clear and precise approach on how each component of the project will be analysed. These components listed below are taken from the Technology Evaluation and Commercialisation Module Guide which serves as a guideline to validate the processes within this project [1].

- Idea Generation and selection – This is the first aspect of the project, to identify an idea that supports the set parameter for this project. The Double diamond technique was used [2].
- Product/Market Description – The T.P.M worksheets were used to extract information such as technology, product and market descriptions from the idea that was initially created. This aided to perform critical analyses on the project [1].
- Functional and Strategic assessment – This contributed in evaluating the functionality and advantages of the project such as Operations, Marketing, Legal, Team organisation and Technology [1].

SMART TROLLEY DESIGN ANALYSIS

The Smart Trolley design consists of the following components. Each component was allocated to different team member to research and submit the required design criteria.

1. Smart Trolley design and user interface
2. Connection to the store database
3. Wireless access
4. Network
5. Scanning product
6. Power
7. Payment methods and generation of receipt

Smart Trolley design and user interface

The Smart Trolley inevitably will require very good and flexible design that will attract the client to use the product. The first question during the group discussion before the design was *"Who are the users, where it will be used and the space the trolley to be placed"*. The answer is the Supermarkets and the users will be anyone using the product in the store; however the space for the trolley will be decided by the store owner. Basically, the trolley play and remain an integral part of the customers' shopping experience and businesses who uses them should ensure that the design meet the requirement of the customers.

- The Smart Trolley should be easy to move around.
- Each Smart Trolley should be fitted with security tracking device to stop people taking it out of the retailer's premises.
- It should be used only for card payments.
- It should be fitted with a Barcode Scanner and a screen device (shopping tablet) to display all the scanned product and prices with *"help"* button that can be pressed for any kind of help.
- Shopping tablet should be user friendly, touch screen, easy to use, fitted to the trolley and has dynamic low power saving mode and Wireless enabled.
- The smart device should be able to link or connect with the store database for product search and item browsing.
- The trolley should be designed with four wheels, a break and easy to handle or steering.
- After shopping the device has the capability to send a receipt via text message or email if needed by providing your number or email address.
- Requires power supply for all attached devices.

To achieve the desired functionality for this product, multiple input and applications are needed, such as network connection (Wireless, database, security, payment method, etc...)

Collectively, in the initial stages of the design, it was decided to design a trolley with four wheels and breaking facility to create stability when pushing the trolley and avoid collision also facilitate manoeuvre when inside the store. A full description of the proposed Smart Trolley is illustrated in **Figure 1**.

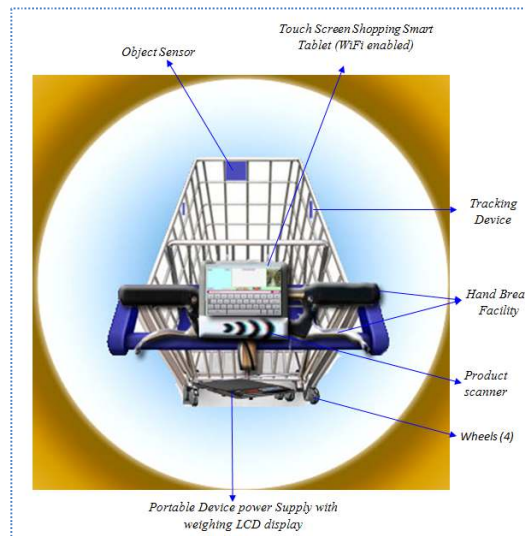


Figure 1: The Smart Trolley Design ^[3]

The components of the Smart Trolley design are [3]:

- Object Sensor: Helps to detect closer object to avoid collision.
- Touch Screen Shopping Smart Tablet: Assist you for shopping.
- Tracking device: Synchronise with the store security system to avoid any kind of theft. This will also let you know if an item has not been scanned by a beeping smooth sound.
- Hand Break facility: For stopping the trolley by applying the brakes.
- Product scanner: Used for scanning products.
- Wheel: Helps to roll/push the trolley.
- Portable device power supply: Provide electrical energy to Smart Trolley.

The benefit of this product is to make shopping much easy, flexible and time saving. The Smart Trolley will be design with a tablet screen and a till application. **Figure 2** illustrates the user interface design to be implemented on the Smart Trolley.

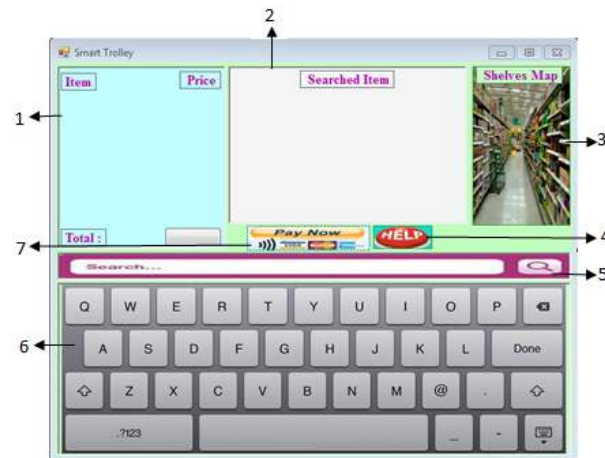


Figure 2: User Interface Design [3].

Description:

1. Panel screen for the scanned items and prices.
2. Panel to display the searched item.
3. Store shelves map, helps to find item location.
4. Help button provides user guidance about using the trolley.
5. Search bar for searching any item located in the store.
6. Keyboard for typing
7. Pay button to activate payment function. Only card payment is supported for security reasons.

Connecting to the Store Database

Database connection is the process by which client software communicate with a database server. The software uses the database connection to send requests and get replies from the database server. The database holds information that can be queried by the client software [4]. For the purpose of this design, the client software is the application installed on the tablet which is connected to the store local database or the company centralised database.

It contains product information, location, availability and pricing. Connection to the database is user friendly with a simple and interacting interface. Customers will be able to search for products local to the store and if it's not available in the store, provides information of the nearest store that has it. The product location (that is aisle and shelf number) can also be displayed on the screen of the tablet on the Smart Trolley and advice on the quantity available in the store.

The present design allows the tills and self-service checkout to have direct access to the store database because they are all directly connected to the network with the database server. However the self-service checkout only allow customer to pay for items. The tablets on the Smart Trolley will also operate in similar way through wireless access. All the Smart Trolleys will be directly and securely connected to the store Wireless Local Area Network (WLAN). It has access to the store and online access to the company centralised database. The

application for the tablet will be designed to work similarly as the application installed on the self-service check-outs. However, the design will have more features for user interaction such as locating products within the store and access to the company centralised database to let the customers have access to products from other stores. This will allow customers to have the opportunity to place or hold an item from other store that is not available at the local store. Other features include PayPal payment which allows customers to use their PayPal account to pay for items. This feature will require internet on the device, however for security reason no browsing capability is enabled on the device except access to the company website.

The design requirement includes:

- Access to the company Local Area Network (LAN) over Wi-Fi. The devices must be in a secure WLAN to protect the company from any intruder or hackers.
- Designing and installing a modified till application on each tablet.
- Update the existing database.
- Connection to the database. This is a set of programing instructions that enables the application on the tablet to access the database server.
- Permissions to access both local and centralised database in the company domain.
- Permissions to access resources on the network just as the tills or self-service check-out.

Wireless Access

Wireless access provides connection for the tablet to connect to the store LAN and access resources. Each tablet has Wi-Fi capability. The devices will be place in a separate subnet, but have direct access to resources just like the tills and self-service check-out.

For security reasons the Service Set Identifier (SSID) or wireless network name for the Wi-Fi should not be broadcasted in order to prevent hackers to have access to the store LAN. Also the Wi-Fi only accepts connection to devices whose MAC address has been permitted through the firewall. This is added manually.

Device can also connect to the internet; however browsing is restricted for product search from the company website and online payments.

Networking

The technique for networking in Smart Trolley should have fast speed, reliability, cost effective, minimum energy usage and communication with other trolleys and also to the base station of the shopping center in order to ensure efficient customer service and also able to deal with any discrepancy or dishonest activity at the customer side [5].

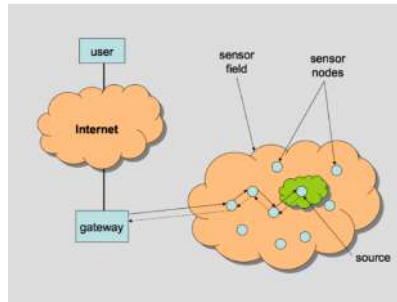


Figure 3: Multi hop Wireless Sensor Network Architecture [5]

There are many methods for wireless communication between devices but finally selected Wireless Sensor Networks (WSN), which is advancing in today's communication field with a very high pace having suitability in the wide range of applications. It has numerous small, cost effective and low powered autonomous devices known as sensor motes. These nodes can be simple or complex and deals with environment sensing perform computing and wirelessly communicate with other devices of the network and self-arrange them after deployment in ad hoc fashion. Each node has the processing capability and has the following components [5][6]:

- One or more microcontrollers
- CPU (Central Processing Unit)
- DSP (Digital Signal Processing) chips
- Radio Frequency (RF) transceiver (mostly with a single omnidirectional Antenna)
- May contain multiple types of memory (program, data and flash memory)

By using WSN in Smart Trolleys wireless communication between nodes or other trolleys reduces processing to great extent as all the processing is done in individual trolley instead of sending packets or data to other trolley.

Each customer is identified in the store premises with a unique ID of the trolley, picked up for shopping purpose. At payment counter there is a base station, has database for keeping all information about products and sensor mote. It has a gateway node as shown in **Figure 3** that can communicate with all Smart Trolleys in the store.

There is a tablet fixed on each Smart Trolley and it is assigned with an IP address and Wi-Fi access of the store whose purpose is to help customers for finding products by browsing store's website and there location as well. If in a case that product is not available in the store, the device will indicate the nearest branch of the store which has that specific product. When customer buys a product and scans it and placed the product in the trolley, its barcode is send through sensor mote to the base station wirelessly by using IEEE 802.15.4 (ZigBee Protocol) over ZigBee Network. ZigBee is selected with sensor motes that are also compatible with IEEE 802.15.4.

Moreover, ZigBee can transfer data to longer distances by passing the data over the underlying mesh network of WSN with low power consumption up to the distance of 10 to 100 meters line of sight or more depending upon the environmental conditions and size of the network. Mostly ZigBee defines the data rate of 25Kbps in intermittent data transmissions from sensors. So, after sending information the base station replies with the description of the product. It also provides location indication by defining row and shelves number on the tablet of Smart Trolley as mentioned in designed part. Now the process moves to the payment procedure.

Security measures against discrepancies or dishonest activities

Beside many other functions, Smart Trolley ensures security measures by considering special cases and giving its solutions. These cases are mentioned below:

- A customer forgets to keep a product into the trolley after scanning it.
- A customer scans one product but place multiple products in the trolley.
- A customer attempts to take away products in the trolley without scanning them.
- A customer changes mind and remove the product from the trolley.
- A customer scans a cheaper product and places the expensive product having same weight.

The design of the product carefully considers all these cases, which are mentioned above. Basically to ensure automation of the system, the scanner is connected to the base station located at the payment counter. When a customer scans a product all the information such as price and name of the product is displayed while the weight of the product is also stored in the database against all barcodes.

Weight of products is an important factor to double check the identity of product to protect against discrepancy or dishonest activity. A load cell, which is basically a weight sensor, is located at the bottom of the Smart Trolley. The output of the load cell helps in decision making against abnormal activities. For example if the weight of the product measured by the load cell is not matching with the actual weight of the product then it is referred as a case of discrepancy at the base station [5][6][7].

If any customer after purchasing the product changes his mind and wants to return the product, he just has to scan the product again, product picture will be taken to confirm intended product from the Smart Trolley's tablet.

In a case where a customer may scan a cheaper product and places an expensive product in the Smart Trolley, there is another important security measure to ensure the third level of check. It is the placement of a small camera with a barcode for image processing. So when the product is scanned a picture of the product is taken at the same time the customer's trolley ID and barcode picture is sent to the base station through sensor mote by ZigBee packets having relevant information.

Scanning Product

The Smart Trolley will have an NFC technology installed that combines RFID (Radio frequency identification) in scanner so that the sale items are scanned much faster and more efficiently with a communication based on line - of -site (LOS) system.

The combination of RFID and NFC system enables to generate electromagnetic field for both transmitter and receivers, and also permits that the detection between scanner and barcode can be registered by sending the information to supermarket database and it is automatically displayed on Smart Trolley monitor.

The scanner is also well equipped with a system that enables customers to remove the product that was already scanned without any problem. The customer can place the item already scanned on shelves again, and continue shopping.

Power

Power is the essential portion of Smart Trolley as it is equipped with a tablet which requires about 5 to 7 volts and a load cell which requires 9 volts. As the sensor nodes are very small devices they can only be equipped with a limited power source of less than 0.5 to 2 ampere hour and 1.2 to 3.1 volts. All these devices need to be powered by rechargeable power supply. A system is provided for continuously recharging the power supply as the shopping trolley is propelled by the customer. The system works in a way that the wheels of the Smart Trolley are linked to a potential energy storage component, such as a coil spring. The spring is wound with each movement of the trolley, regardless of the distance that the trolley travels. When the coil spring has been wound to a pre-determined torque, the spring is released to drive an input to an electrical generator. Once the potential energy in the spring has been dissipated the winding cycle begins again and due to consistent moving of the trolley wheels provide power to the rechargeable devices [9]. A typical design is shown in **Figure 4**.

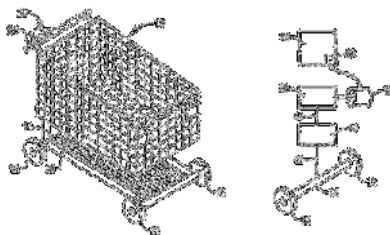


Figure 4: Power generation for the devices [9]

Payment Methods and Receipt Generation

Payment method allows users to complete their purchases from the Smart Trolley. The present payment system on the tills and self-service checkout allows for both card and cash payments, however for security reasons and to deter theft, the propose system can only accept card payment. This can be achieved in two ways.

- Customers can enter their card details through the till service application and processed online.
- Using the wireless chip and PIN device on the Smart Trolley.

When customers finish shopping, the terminal of Smart Trolley will automatically send receipt via text message or email to intended customer [10]. For registered customers, it is not required to fill in personal information such as email address and phone number every time, this will already be stored in the store database.

PRODUCT AND MARKET DESCRIPTION

The market description presents a competitive analysis of the product market and its attributes. The table worksheets below illustrate the full description of the Technology – Product – Market (T-P-M) and the Product Attributes [1]. These are aided to understand how the product will be made and meet the needs of the intended users.

<u>Technology Description</u>	<u>Product idea</u>	<u>Product Market</u>
Smart Trolley	An innovative way to make shopping easier, time saving and secure	Super Stores and Shopping Centres
<u>Capabilities of Product</u> <ul style="list-style-type: none">• Mobile self-checkout system• User interactive system• Time saving• Ensures security• Customer can locate desired products in store.• Support card payment• Generate E-receipt		<u>User Needs</u> <ul style="list-style-type: none">• Time saving• Easy product search in store• Avoid long queues for payment• Mobile shopping experience

Table 1: Initial Technology – Product – Market (T-P-M) Worksheet

Technology Capabilities	User Needs	Segment	Product	Feature
Smart Trolley connected to store database for product specifications	Description of products	Customers and Retailers	Smart Trolley	Faster way of shopping to attract customers
Self-scanning of products by customers	Skipping long queues for payment			Easy shopping procedure by smart interface
User interactive interface to locate items in store	Making product search quicker			Efficient product search application
Card payment facility	Secure way of payment			Reduction of till loads, E-receipt

Table 2: Product Attributes

TEC – ALGORITHM WORKSHEETS DISCUSSION

Phase 1: Functional Assessment

The functional assessment phase was well received based on feedback from both super stores (retailers) and end users (consumers). This was due to the results obtained from the worksheets when an idea exploration of the Smart Trolley's functionalities was conducted. An attached copy of the results can be found in the Appendix of this document.

The Smart Trolley was legally analysed to raise concerns about significant and composite issues surrounding copyrights and patent legislation with the UK and International laws. As this technological invention requires the necessary legal framework for any uncertainty about the product in the future.

In the marketing aspect of this project, the Smart Trolley required less amount of marketing as this was due to the fact that it is new in the retail business and also there are no direct competition, but this will be reviewed as required in the future. The Smart Trolley has gained much interest from retail gurus that have made high

projections about the number of Smart Trolley that will be needed by super stores in the UK and perhaps across other parts of the world. However, influencing these retailers to buy our product will be challenging due to cost of production, including technologies that will be used in the Smart Trolley.

The technological features of the Smart Trolley have been proven to be successful in other products; therefore this product has what it takes to succeed. These features will improve shopping experience by a fast and easy method of shopping and making payment for items. This will encourage lots of shoppers because they do not need to queue up to make payment of items. By having such a retail machinery, end users will be increased which will result in high returns for the super stores. The design of the Smart Trolley is capable to cope with any changes in the future.

The finance aspect is very important in any technology project. As the business stands, there is no access to funding sources yet but will be seeking for potential investors. At the current stage of this project, prototype to be developed will have to be self-funded. The product's short-run and long-run cash flow cannot be determined at this phase of the project.

Phase 2: Strategic Assessment

The strategic phase assessment was conducted and feedback received from both retailers and consumers. The TEC algorithm worksheets used to collect information for this phase are attached to the appendix section of this report.

The Smart Trolley copyrights and patent was legally analysed in phase 1 and it is for the interest of the business to be protected by law. There is no patent disclosure and copyright protection submitted at present for the Smart Trolley, however this will be submitted in the future for approval in order to protect the product from any infringement.

The target market for this product is the superstores retailers. The supply of the product will depend on the demand from the retailers. Demand is predicted to be high because the response from consumers shows that the product will be well appreciated by the public due to its features such as mobile checkout and product search which has not yet been implemented. Based on this prediction, the expected market share will be great once the product is launched.

The design and development team for the Smart Trolley are experts with the right technology skills to deliver the project on time. The team members meet regularly to discuss objectives and progress. They sometimes disagree and deliberate on topics until an agreement is reached. Every member is given a task with a schedule time to deliver.

The Smart Trolley is mobile and provides users the flexibility to make transaction from the Smart Trolley within the business premises. It is reliable and highly efficient, because it is fully synchronised with the store database, has GPS tracking enable, uses less power and does not require external power source. This is a new technology and has not been implemented yet. However all the expertise put together to make the Smart Trolley are existing technologies. There will be high market potential as the users responds shows that it will be a great shopping experience. It can be very costly to produce, but operation cost will be low with high performance. This is because low power is required to support the Smart Trolley and it is self-powered when the Smart Trolley is in motion. There are few issues of concern, such as security and theft; however this can be addressed during design and implementation stage.

Critical analysis was carried out for the finances required for the business. At this moment there is no access to funding sources, all initial investment has to be funded by the group. However, it is anticipated to get funding and partners once the product is launched.

CONCLUSION

The Smart Trolley was designed to function as a mobile self-checkout system providing users the flexibility to make transactions from it within the retail store. It is designed to be highly efficient and fully synchronised with the retailer's current system.

The double diamond standard was used in the product idealisation phase which guided the team to choose the Smart Trolley idea among many other ideas presented by the team. The TEC algorithm then used for analysing the business idea using the worksheets presented in this report. By using the algorithm, it can identify the market potential of the Smart Trolley and the problematic areas, so that it can be presented with a successful business plan.

A detailed market description and competitive analysis of the product market and its attributes were presented in this report. The target market identified was the big retailers; however consumers are the direct beneficiaries. From the responses received using the worksheets presented in this report its clear that the product will be very much appreciated by the public because of its unique features such as the mobile self-checkout and easy product search within the store.

From the feedback responses obtained from both the Functional Assessment and Strategic Assessment phases, the Smart Trolley will gain a very good market. This will attract partners and funding once the product is available in the market. For these reasons the product must be protected legally.

Security and legal protection must be given high consideration for this product; however this is not necessary at this moment because there is only presentation of ideas and business plan with no prototype developed yet.

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