Consumer Technology for Sustainable Food Practices

– The impact of mobile applications on consumer food behaviour

Nathan Pflaum

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Abstract

A food system is a long chain of activities comprised and contributed by multiple industry inputs and processes where a consumer in the food system is typically represented at the end of the value chain. A sustainable food system recognises the various influencing factors throughout the value chain and considers social, economic, and environmental impacts along all steps.

With a system thinking approach to a sustainable food system, this thesis explores the use cases of consumer technology in driving consumer behaviour toward more sustainable food practices. Through triangulation data collection comprising of a literature review, corporate material, and corporate interviews, mobile applications which aim to track user carbon emissions and behaviours are evaluated for their ability to influence consumers toward more sustainable food habits. A qualitative review is conducted comprising of six companies utilising consumer technology and applying behavioural economics to promote more sustainable actions.

An individual's carbon emissions produced by their food choices can be considered minimal in comparison to an entire food system or even global emissions, consumers can be viewed as a driver for change within an industry. Consumers may exhibit habitual decision-making processes that can become more cognitive and extended through nudges, education, and suggested actions. Consumer technology values (primarily hedonistic, egoist, social, and utilitarian) must be addressed for apps to have a continued value and long-term use by an individual.

Data collection, accuracy in reporting, and scalability are challenges faced by companies providing carbon or sustainability tracking mobile applications.

Keywords: Consumer Behaviour, Consumer Technology, Sustainable Food Systems, Decision Making

Table of contents:

Contents

List of Tables

List of figures

Abbreviations

GHG	Greenhouse Gas(es)
CO2	Carbon Dioxide (relating to emissions)
Apps	Mobile phone applications
SSI	Semi Structured Interviews
LCA	Life Cycle Assessment
SLU	Swedish University of Agricultural Sciences

Introduction

Consumer technology is technology which has been designed and intended for anthropogenic use, such as mobile phones and computers (Builtin, 2022). With adoption of consumer technology, research has shown that consumers exhibit predictive variables in determining behavioural outcomes (Yang, 2012). Close interaction with consumer technology products – primarily mobile phone apps have an opportunity to educate and help to facilitate change in a consumers food choices. Technology-aided tailored interventions have proliferated in the health and wellness space and have been shown to be efficacious in changing a variety of behaviours (Ryan et al., 2019). High touch points, constant feedback, and other behavioural tactics such as gamification and nudging may be implemented through mobile apps to influence a consumer toward more sustainable food practices.

The Paris Climate Agreement, an international treaty on climate change adopted by 196 parties in 2015 (UNFCCC, 2022) strives to limit global warming to under two degrees Celsius below pre-industrial times (UN, 2015). To reach goals set by the Paris Climate Agreement, reductions in carbon emissions and greenhouse gases must be reduced by 45% by 2030 and net zero by 2050 (UNCA, 2022). While industrial practices and carbon dependent technologies in transportation, electricity production, and agriculture are responsible for a vast majority of GHG emissions (EPA, 2022), commercial and residential emissions may contribute up to 13% *(ibid)* in the United States. This paper investigates the potential for consumer technology to influence an individual toward more sustainable habits, in particular – more sustainable food practices. While commercial and household GHG emissions may be relatively low by global standards at 13%, consumers could be a driver for (Hazell and Wood, 2007) change toward industrial and agricultural practices which produce less CO2 and GHG emissions. While there are many activities within a food system which happen without any consumer input, an individual's food activities have potential for varying degrees of sustainable outcomes (Ericksen, 2008).

The current global food system now must support nearly eight billion individuals with an expected population of nearly ten billion by 2050 (UN, 2022), but it is currently a major source of poor health and environmental degradation (Clark, 2019). Sustainable Healthy Diets are dietary patterns that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable consumer food waste (FAO, 2019). The sustainability of a diet should also be viewed in a systems approach as the entirety of the value chain will have an impact on the many elements of a sustainable diet. Beyond the wellbeing of an individual making healthy and sustainable food choices, the environmental impacts can be directly influenced by a consumer's purchasing decision and food practices. For example, reducing meat intake can have a significant impact on the greenhouse gas (GHG) emissions that are an outcome of animal production. A global adoption of low-meat diets that still meet nutrition and caloric requirements can lead to as much as a 50 percent reduction in GHG (Clark, 2019).

Individuals have a habitual or unconscious decision-making process in which choices are made with little to no level of conscious or cognitive thought (Bernacer et al., 2014). Further, consumers do not often have an easy and clear way to determine what carbon impact their food purchasing decisions have on the environment (Langlands et al., 2021).

This thesis has a primary focus on the consumer's food practices. While a sustainable food system encompasses and entire network and value chain of actions and stakeholders (IFST, 2018), this paper aims to narrow down the research field by focusing on the consumer and how their interactions with food lead to more sustainable outcomes within the food system. Consumer food practices for the sake of this thesis are defined, but not limited to the following activities: **Purchasing** decisions include types of food to be included in a diet such as meat or vegetables. **Food waste** is limited to household waste and not food loses or waste throughout the food supply chain. A consumer's decision to **cook or eat out** may have a significant impact on their carbon emissions depending on the venue and food being prepared. Lastly, the **source** of the food supplier will have an impact on both the consumer's decision-making process and the direct or indirect carbon emissions.

Aim

This paper aims to identify tactics, models, and the efficacy that carbon tracking mobile applications have on a consumer's decision making and behaviour toward sustainable food practices. Carbon or sustainability tracking mobile applications do not necessarily limit their influence toward food, many companies included in this case study formatted paper provide suggestions and tracking of a consumer's carbon emissions in many aspects of their daily routine. This thesis includes companies which have some aspect and intention to influence a consumer's behaviour and habits toward their food practices.

To do this, a case study of six companies is conducted along with theoretical exploration and a narrative literature review. Three questions are introduced here to provide a framework which works alongside the theory introduced in the next chapter.

- What do companies with sustainability or carbon tracking mobile applications currently do to help influence more sustainable food practices by the consumer?
- Does consumer technology have a place in influencing behavioural change and developing sustainable food habits?
- Which motivating factors lead to change?

With an aim to provide insight into some of the more successful tactics being used by products that aim to influence a consumer's behaviour, this paper can identify and perhaps suggest best practices. Further, looking at the efficacy of tracking a consumer's purchases, this paper can discover some of the issues which are presented by the interaction of a user and the visualization or depiction of their carbon emissions.

2. Theoretical perspectives and framework

This section introduces several theories which are pertinent to the research portion and will be applied to the companies being included in the case study along with the discussion at the end of this paper. The theories selected fall into two broad categories, the first being sustainability within a food system and the second being used in the sphere of behavioural economics or consumer behaviour. Together, the theories presented in this chapter will provide a framework to structure the results and discussion chapters found further in this paper.

2.1 Sustainable food systems

A food system involves a long chain of activities ranging from the agricultural input to processing, retail and ultimately consumption and disposal. Food systems are the sum of actors and interactions along the food value chain—from input supply and production of crops, livestock, fish, and other agricultural commodities to transportation, processing, retailing, wholesaling, and preparation of foods to consumption and disposal (IFPRI, 2022) A sustainable food system accounts for economic, social and environmental considerations, FAO defines a sustainable food system as: a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO, 2010).

In a food supply chain, the consumer is often defined at the last step where their interaction has a multitude of influence variables ranging from food waste to sustainable diets and food culture (IFST, 2018). The food system in this thesis will focus on the consumer and their food practices which primarily encompass the following: purchase decisions, food waste, meals and nutrition.

Food waste and food loss should be reduced in a sustainable food system, any unconsumed food indicates that all inputs required throughout the supply chain have been wasted. **Food loss** and **food waste** are two definitions that can be distinguished primarily by their activity in the food chain. Food loss is the decrease in quality or quantity of food resulting from decisions and actions by food suppliers along the chain. Food waste is the decrease of quality or quantity of food resulting from the decision and actions of the consumer (FAO, 2022). This important distinction is relevant throughout this paper as food waste is the primary concern of the consumer and it is where consumer behaviour and decision making can be influenced toward more sustainable options. The FAO estimate that one third of food produced globally is lost or wasted *(ibid)* while the UN stating that 17% is lost to waste, and 11% is household waste (UN, 2021).

Food system models

Two food system models have been identified to help build the framework for the purpose of this paper. Both models advocate for a systems thinking approach which allows for a deeper understanding in the critical factors that lead to particular outcomes or the interactions that govern a specific behavior of interest. (Ericksen, 2008).

The first approach being the Institute of Food and Technology (IFST, 2018) FIG 1 food system which explores the key components of a food systems within six themes, (1) resource risks and pressures, (2) healthy sustainable diets, (3) circular economy and sustainable manufacturing, (4) novel production systems and ingredients, (5) decent work and equitable trade, (6) transparency, traceability and trust*(ibid)*. While this offers a framework of an entire food chain, this thesis will delimit most steps along the value-chain prior to the consumer. Below is a model based off the IFST food system designed to better illustrate the consumer impact of a food system as the last link in a long and complex chain. In the venn-diagram-like model that there are many overlaps throughout the framework where a consumer may contribute toward a more sustainable food system and system outcomes. Among these elements are healthy sustainable diets, consumer waste, food security, food culture along with communication and education. Working together with the model below, Ericksen's Components of a Food System Fig 2 is used to illustrate food system outcomes.
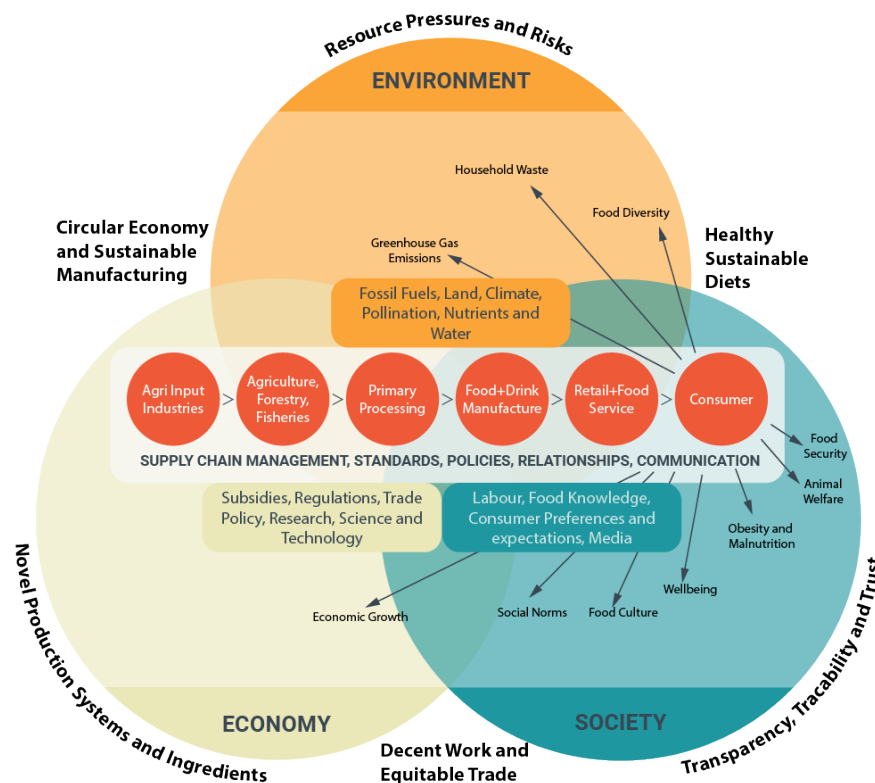
Figure 1: Sustainable Food System highlighting consumer impacts, influenced by IFST model

Ericksen's model (below) takes a holistic approach which includes feedbacks and interactions among drivers and considers multiple outcomes (Ericksen, 2008). Ericksen's food system model is designed to help analyse the feedback from food system outcomes including drivers for social and environmental impacts *(ibid)*. Ericksen's components of food system outcomes model encompasses the importance of a systems approach to ensure food security, social welfare, and environmental security. The food systems outcome model Fig 2 below is designed to illustrate, identify, and analyse the consumer impact toward a sustainable food system. This model is used to help identify opportunities where the consumer may be able interact to help create a more sustainable food system because of their actions.
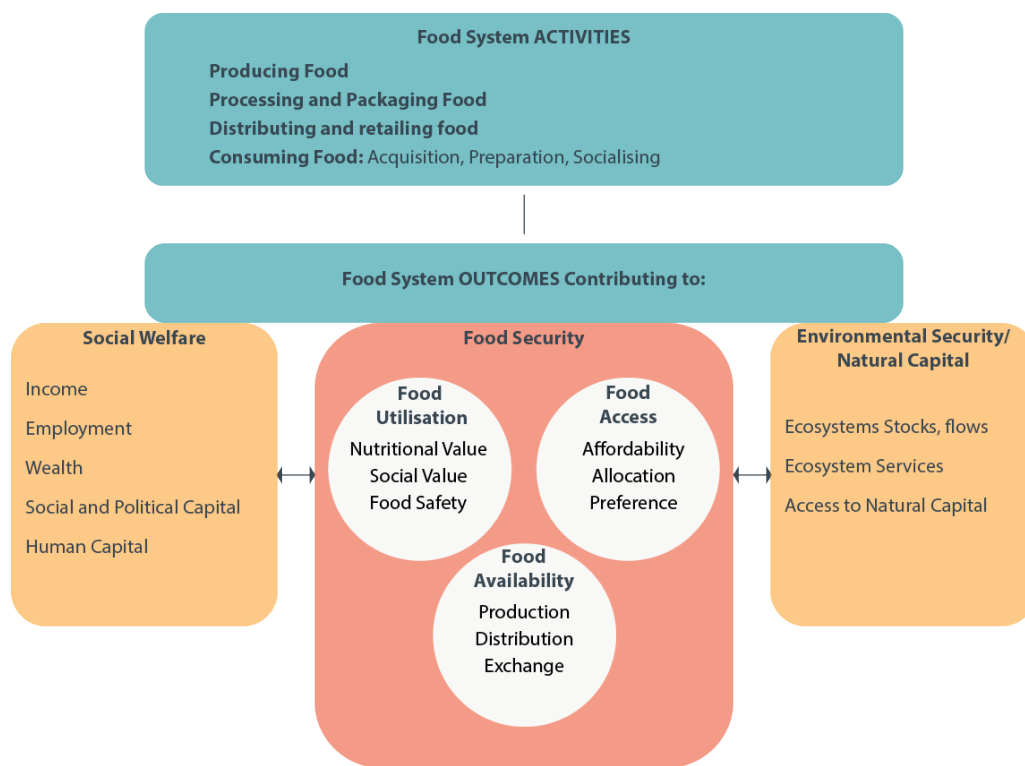
Figure 2: Food System Outcomes, influenced by Ericksen's food system model

The original purpose of the Ericksen's model is designed as an analysis tool to study global environmental change and the major societal impact through the interaction of: food security, ecosystem services and social welfare (Ericksen, 2008). In the adapted model above, food system activities are limited to consumer interaction and consider food system outcomes in relation to the consumption of food (acquisition, preparation, socialising etc) and consumer behaviour.

Food consuming or consumption is defined by all interaction and decisions acted on by an individual. This is inclusive of preparation, selection, eating, and waste with consideration of pricing, income, social-cultural influences and education. As there are many variables, this model is used to analyse potential outcomes and develop certain strategies which may be

employed to lead to more sustainable food system outcomes. Within the context of consumer technology, the model above may be helpful to determine key activities and behaviours where an individual can make changes toward more sustainable interaction with food, thus improving food system outcomes.

Within the model, food security (Figure 2) a mobile application which encourages sustainable food practices may have potential to increase a consumer's awareness and decision making toward more sustainable behaviour. Likewise, acquisition, preparation and food socialising are all components of a sustainable food system in which social norms could lean more toward sustainable habits. Food system activities lead to food system outcomes, we see a plethora of ways a consumer's activities can impact the outcomes. Consumer outputs are not to be overshadowed by the inputs and activities that are established by entities within the existing value chain in the food system (production, policy, processing etc). Through carbon or sustainability tracking apps which leverage elements of consumer behaviour, there is may be potential for a consumer to both become more aware of the issues around an unsustainable food system and how their actions can have a positive impact. The model presented above helps to illustrate the food system outcomes which can be directly correlated with consumer habits.

Sustainable Diets and consumer food waste

A healthy and sustainable diet must be considered beyond their environmental impacts, health and nutrition must also be inclusive in a sustainable diet. Beyond this, other factors such as fair-trade, culture and heritage are also considered equally important according to the FAO in their key components of a sustainable diet (FAO, 2010). An adaptive model from the FAO 2010 summit on sustainable diets is represented below in FIG 3. In a workshop on sustainable diets, food and nutrition Drewnowski stresses that diets may only be sustainable if they are healthy to begin with (Fukagawa, 2019). Taking a systems thinking approach toward sustainable diets emphasizes the importance of sustainability including more than just an ecological or financial model of longevity.
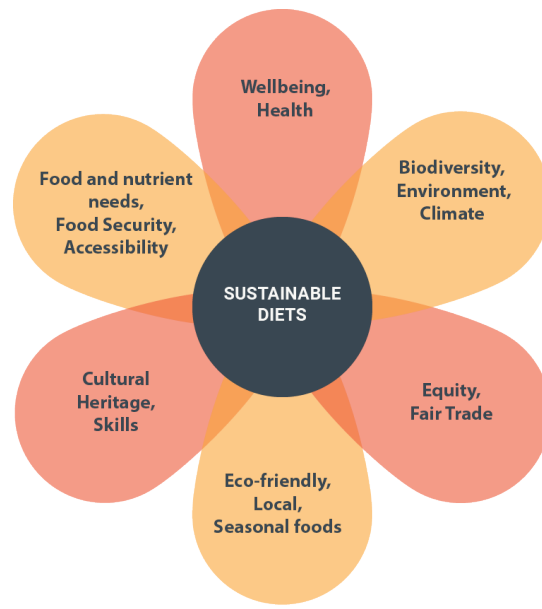
Figure 3: *Model based off FAO 2010 sustainable diets*

Food waste can significantly impact the sustainability of a food system. Unconsumed or destroyed food wastes the resources that have gone into production throughout the supply chain further, household or consumer wasted food that could have remained in the supply chain would potentially increase food availability and access for other consumers. In the United States alone, this represents $160 billion in economic losses (Muth et al., 2011).

Food waste can occur throughout various stages of the food supply chain, approximately one quarter of food supplied for human consumption is wasted (Stancu et al., 2016). It is difficult to accurately calculate total food waste contributed by the consumer as current data on uneaten food do not exist. (Yu, 2020)

Though (Stancu et al., 2016) posit that about half of the total food waste in high income countries occurs at the household. With the consideration of high amounts of food waste being contributed by the consumer, there is a need to explore opportunities to change or influence consumers toward more sustainable food practices.

2.2. Consumer behaviour

Consumer behaviour is an ongoing process that extends beyond the interaction of purchasing a product, it is an extended view of the consumption process which emphasizes the interactions before and after acquisition (Solomon et al., 2016). Within this process there are multiple factors at pre and post purchasing stages that influence a consumer behaviour and interaction with a certain product or service. The attitude-behaviour gap or values-action gap relates to a process in which a consumer feels a certain way about an issue or subject, yet they may have contrary actions which do not support their views. In a paper by (Young et al., 2009) (Barboza and Filho, 2019) the authors establish that 30% of consumers have concerns about environmental issues but fail to make purchases that support their views. Established in the earlier theories introduced in this paper, a consumer's food practices can have significant impacts on the sustainability of an entire food system.

Ajzen's (1991) Theory of Planned Behaviour describes behavioural intention to be a function of three elements: **Attitude, Subjective Norms** and **Perceived Behavioural Control** (Ajzen, 1991). With Attitude reflecting on one's positive or negative feeling by performing a certain behaviour, Subjective norms relating to the social environment and the beliefs of those surrounding the individual when they perform a certain behaviour, and Perceived Behavioural Control referring to how easy or difficult a behaviour may be to perform *(ibid)*. Understanding that a values action gap within consumer food habits and practices exists, we look at ways that action can be taken to close the gap and influence consumers toward more sustainable food behaviours.

Nudging is a concept largely popularized in Thaler and Sunstein's 2009 book titled 'Nudge' (Thaler and Sunstein, 2009). While the exact definition of a nudge is difficult to define and is continuously evolving (Simon and Tagliabue, 2018), Nudging is defined as "…any aspect of the choice architecture that alters behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler and Sunstein, 2009). In a completely neutral setting, also known as *neutral choice architecture* (Simon and Tagliabue, 2018) a consumer will have no influences on their choices to reach their desired outcome. Though there are hardly conditions when such an example of neutrality might exist (Thaler et al., 2014) especially in the context of readily available information and influences being accessible through internet media. With the acknowledgment of an attitude-behaviour gap (or values-action gap) a consumer may need some level of influence to steer people towards choices that align with their values (Langlands et al., 2021). A values-action gap exists in which the consumer may want to behave in a certain way but lack the means (resources, education, time) create the action. Nudges can be used in various forms, supermarkets have used nudges in many ways, from putting sweets and fast grab items near the cashier allowing the consumer to act on heuristics or placing dairy alternatives next to whole milk which easily shows the consumer alternatives to their regular purchasing behaviours.

Closing the attitude-behaviour (or values-action) gap could require a shift toward more cognitive decision making in the short term to form new habits. In a process called constructive processing, an individual will evaluate the amount of effort needed to make a choice, forgoing a constructive process, an individual may relate back to habitual behaviours to avoid a confronting thought process (Solomon et al., 2016). To illustrate the categories of consumer decision-making, the Three Buckets of Consumer Decision-Making *(ibid)* FIG 4 is considered in this thesis. While this model is built off three categories, they are not necessarily independent of each other and ultimately a decision is made through multiple feedback loops, heuristics and social/cultural influences.

COGNITIVE   **HABITUAL**   **AFFECTIVE**

Deliberate
Rational
Sequential

Behavioural
Unconscious
Automatic

Emotional
Instantaneous

Figure 4: Consumer decision making. Influenced by Three Buckets of Consumer Decision Making

Limited vs **extended** problem solving helps to illustrate a decision-making process. The extended problem solving requiring more cognitive input and often greater information is required to come to a final decision. An individual aiming to close the values-action gap in adopting a more sustainable lifestyle will engage with a more complex decision-making process (Young et al., 2009). Whereas the Limited problem-solving stems from a more affective or habitual process allowing the consumer to fall back on subconscious behaviours and information. This thesis will explore methods that can be implemented through mobile tracking apps to help close the attitude behaviour gap and reduce the level of effort needed shift toward a cognitive process that leads to more sustainable food consumption behaviour.

Use of Gamification to influence consumer behaviour

Gamification is the idea of taking game elements and using them in non-game contexts to motivate an individual toward a certain behaviour and to increase user activity and retention. This is achieved through implementation of mechanisms and structures to real world use cases to help motivate and change behaviour in users (Agnieszka, 2014). Some of the more important elements of gamification include a dynamic digital environment, short- and long-term goals, frequent feedback, rewards and a manageable degree of uncertainty in a low-risk environment (Solomon et al., 2016). As a concept and practical application, gamification is being increasingly harnessed by companies for interaction design and digital marketing (Deterding et al., 2011). Like the values-action gap described previously, consumers may have an understanding of social or environmental issues and goals, but desire incentives to participate actions that benefit such issues. (Mulcahy et al., 2020) find that *"self-oriented behaviours such as monetary savings and economic incentives are frequently more effective than abstract appeals such as pollution reduction"*.

Gamification allows a user to explore certain aspects of an idea or goal with a relatively low impact and risk. It is a technique that can be used to encourage users to experiment with a 'freedom to fail' (Stott and Neustaedter, 2013), low risk actions which are designed to be forgiving if a user fails within a certain task. Other key factors applied through gamification include rapid feedback, progression, and storytelling *(ibid)*.

2.3. A Conceptualised Analytical Framework

As an analytical framework Fig 5, described models are combined to create a conceptual framework applied in this study. This conceptual model takes elements of a system thinking approach focusing on consumer interaction with consumer technology in the form of mobile applications. Previous models introduced in this theoretical perspective chapter highlight the benefits of systems thinking approaches and how multiple factors impacts a value-chain. The consumer is the key factor in the value chain this model considers through the lens of consumer technology as the driver for behavioural change toward more sustainable food practices.

By taking elements of a systems thinking approach introduced in the Institute of Food Science and Technology (IFST, 2018a) and Ericksen's model on food system outcomes (Ericksen, 2008), the model is used as an analytical lens for behavioural change influenced through the use of mobile applications. The model suggests a positive feedback loop in which consumer outcomes and behaviour change could lead to both resolution of food system problems and identification of new issues. This model is used to illustrate and analyse possible interaction with a consumer in a food system it will help to answer the questions around consumer technologies efficacy in a sustainable food system.

Key inputs and factors which are identified through the research conducted in the case study help develop this analytical framework. New interactions or concepts are discussed and implemented throughout the paper, culminating in a final and simplified version (FIG 9)
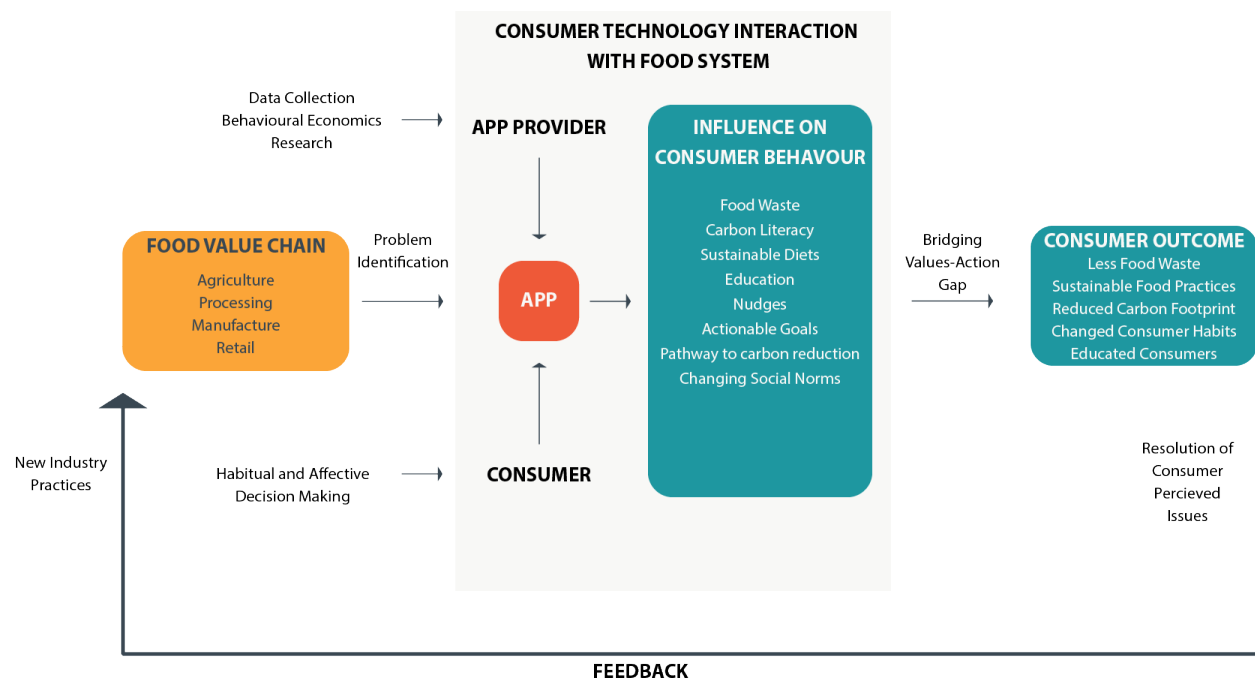

Figure 5: Conceptual Analytical Model *Consumer technology interaction within a food system*
(own conceptualisation - influenced by Ericksen 2008, IFST 2018, and FAO 2010)

3. Materials and Methods

The materials consist of three different types of data allowing for a triangulation of information to be synthesised within the results section. Triangulation is a method of research in qualitative studies which refers to multiple methods or data sources to develop a comprehensive understanding of the topic or phenomenon (Patton, 1999). This thesis uses a data collection method of Data Source Triangulation (Carter et al., 2019) and their various sub methods. Data Source Triangulation refers to collection of data from various sources *(ibid)* such as individuals, communities, companies, and online sources to gain multiple perspectives and validation. This paper collects data from three sources and their methods.

1. A narrative literature review
2. Corporate Material
3. Corporate Interviews

A further sub-collection of material was comprised of a preliminary market exploration of current consumer technology applications which illustrate consumer carbon emissions and aim to change behaviour. Collection of material and their methods are described in their subheadings following this paragraph

Screening-market exploration of current consumer technology

A primary exploratory market search of was conducted to gauge the amount and varieties of companies that offer carbon or sustainable tracking applications directly to consumers. The purpose of this was to create a subset (Hague et al., 2004) in which certain criteria could be established to determine eligibility for the study. This leads to a purposeful sampling in which a qualitative study could be achieved and a more in-depth analysis of each case to be performed (Patton, 1990). This search was executed on online search engines as well as directly through the Google and Apple play stores. Keywords *such as* "carbon tracker" and "sustainability tracker" were used to populate the initial list. On February 15, 2022 a search was made on the Google Play Store and Apple App store using the keywords listed above. Further, online searches for "carbon tracking applications and sustainability applications" returned several existing reviews and lists of multiple relevant organizations that offered phone apps that would track or influence a user's sustainability habits. The list of companies was populated through a combination of online search engines and the top two accessible app stores: Google Play and the Apple App Store

The initial search on the apple app store and google play store returned:
Apple App Store = (n=134)
Google Play Store = (n=247)

Search engines came back with multiple kinds of results, with some pages leading directly to a company's homepage, and others leading to existing lists and compilations of carbon tracking companies. As the purpose of this study is to use cases which have the ability to impact a consumer's food practice toward more sustainable behaviour, some criteria were created.

To narrow the number of cases that are selected for this thesis, the applications had to fit the selected criterion.

- Existing Phone App
- Integrated or manual input of activity data
- Measure carbon impact
- Education and advice
- Behavioural change
- Commitment to creation of new habits
- Elements of gamification (leaderboard, competitions, campaigns etc)
- Can reasonably be linked to sustainable food systems

Being a qualitative study with triangulation of data, the aim was to keep the initial sample size below n=20. After the selection of applications was made that fit the criteria, n=18 suitable companies with mobile apps were selected. This subset would be used as a point for initial synthesis and contact, the purpose of contacting all 18 companies was to allow for the event of non-responses (Hague et al., 2004).

It is worth noting that an element of subjectivity is included in the selection of the final number of companies selected for the case study in this form of data collection. Most of the apps that were excluded were those that had few reviews and users, they were also excluded if they did not have sufficient or reliable information on their websites. An inclusion of companies from a variety of countries was also encouraged to increase the breadth of this study. To achieve more variety in a qualitative study of a relatively small sample size (Patton, 1990), multiple variables were included. Such variables include country, users, key application features and apps which rely on different methods of data collection. Descriptions of each case are synthesized in a table below which allow for greater background information for the purpose of this qualitative case study *(ibid)*.

An overview of the preliminary 18 companies was conducted APPENDIX 2. The purpose of this synthesis is to have an overview of the companies, details about their carbon or sustainability tracing along with the key features of their mobile application. Using this table allowed for common elements and features to be discovered between the variety of companies selected. This information was used to create a theme of questions which could be used for all the companies being interviewed. The interviews were designed to be semi-structured as there were still varieties in the company offerings, for example, some companies had a focus on engaging entire offices or workplaces where other companies were focused on the individual consumer.

Table 1: Selection of companies included in study

App	Launched	Homepage	Downloads*
Cogo	2010	https://cogo.co	60,000 +
Giki	2018	https://giki.earth	50,000 +
Joro App	2019	https://joro.app	5,000 +
Decarbon	2019	https://decarbonapp.com/	600 +**
Ailuna	2021	https://ailuna.com	5,000+
JouleBug	2009	https://joulebug.com	50,000+

*Number of downloads collected from combining google play store and apple app store stats.
**Number stated by the app creator

3.1 Literature Review

A narrative literature review is conducted to have a better understanding of the influence mobile apps can have on changing consumer behaviour. The purpose is to understand the efficacy of behaviour change through technological intervention so that it may be applied to a consumer's sustainable food habits as part of the discussion. A narrative review allows for a qualitative interpretation of prior knowledge (Sylvester A et al., 2013) this review aims to search for evidence of mobile applications influencing consumer behaviour, though it does not limit the results or evidence being related to food systems or consumer food practices. The broad nature of a narrative review has it conveniences though it is a subjective selection of information which may criticized as an unsystematic approach (Green et al., 2006). However, it also allows for a comprehensive background and for the researcher to highlight significant findings which are relevant to the topic of study (Paré and S, 2017). Three online databases were utilized during the search phase: Scopus, Google Scholar and Web of Knowledge with key words including:

Mobile app*, Consumer behavio*, Consumer habit*, Influen*, Health

There was not a specific goal in the number of papers to be compiled in this review, a subjective/narrative approach was taken to judge the appropriate amount of background knowledge (Sylvester et al., 2013). A complete systematized synthesis of the papers was not planned, instead a summary of the key points and results would be compiled in the results section along with a synthesis table. The literature review was used to collate background knowledge in behavioural change within consumer technology which would be applied to the analytical framework and to help define questions for the semi-structured interviews.

Papers included in narrative literature review: **N=13**

A synthesis of the papers can be found in Table 4

3.2 Corporate material

Alternative and additional sources of information would be needed to have a wider breadth of study for better and more accurate validation to be presented in the results and discussion sections. Reviewing the synthesis of companies, a selection of six companies was made to be included in the final study. The selection was made after reviewing all companies and searching for those which had the most available credible information on their websites or social platforms, (companies which responded to early requests for interviews were also included). The paragraph below details some of the other data collection that was used due to the lack of direct response from the companies that would be included in the interviews. Other collection of data was primarily made online by visiting company websites. This allowed for an initial synthesis of the companies which was paired with online search engines and mobile apps stores described in the section above, see Table 2. Companies with whitepapers, methodology or research papers readily available for download would be selected to be in the final study. Many of the companies have some level of social media activity, whether on Instagram, facebook or LinkedIn, these were also sources to be considered for data collection. As interview responses were lower than anticipated, the additional sources of data had to be added to this study.

The availability of corporate material with content to be analysed was an important factor in a company being included in the case study. As the aim of this study was to have between five and eight companies being represented, companies with readily available corporate material would be selected. The table below illustrates the final selection of companies and pertinent information such as a brief description and highlighting key features.

Table 2: Companies Selected for Study

Company	Details	Key Features	Website	Country
CoGo	Integration with existing services to track consumer carbon impact and offering real-time sustainability data. Created their own ethical nudge framework applying gamification and behavioural science principles to climate action	Gamification, nudging, integrated APIs, live tracking and feedback	https://www.cogo.co/	New Zealand + UK
Giki	A personal guide to understand and reduce a consumers carbon footprint. Offering 6 month steps to help change consumer behaviour toward more sustainable actions. Help to create sustainable communities and workplaces by training ambassadors "Chief Greenies"	Education, Gamification, Integrated financials, Goals and pathway to carbon reduction	https://giki.earth	UK
Joro App	Integrated tracking as you spend – allows connection with credit card. Allows the user to automatically spend to offset carbon with their chosen projects	Education, Integrated tracking with spending, leaderboard/gamification	https://joro.app	USA
Decarbon	Integrated tracking allows setting of a carbon budget. Direct carbon offsets	Education, Integrated financial tracking, tips, carbon offsets	https://decarbonapp.com/	USA
Ailuna	Sustainability training app, educating the consumer to create more sustainable habits – strong emphasis on sustainable eating	Behavioural Change tips and pathways, Habit building	https://ailuna.com	Denmark
JouleBug	Carbon impact trackers which utilized gamified elements such as leaderboards and trophies to encourage sustainable activities. Has suggested actions for the consumer to take part in sustainable activities	Gamification, suggestions, leaderboard, trophies, education, social	https://joulebug.com	USA

3.3 Interviews (Contact and Interviews)

All 18 companies that matched the criteria of the search were contacted for interviews which would provide the largest portion of data collection. With the selection and synthesis complete the next step was to directly contact these companies to invite for an interview. This was accomplished by visiting their websites and looking for contact information. N=9 of the companies had contact emails available on their pages while N=6 only provided a contact form which was utilized directly. N=3 companies were excluded after no information was found to be available for contact. A search for employees of these companies was also made on LinkedIn and direct contact was also made there. Consistent with non-responses in cold contact approach this step was taken to increase the chances of a response from the companies to be included in this study (Hague et al., 2004).

One week after initially contacting all of the companies, only one had responded to the request. The second stage of contact was utilized through LinkedIn, a search was made for the specific companies with the idea of being able to contact employees directly. This tactic was executed by searching for employees with roles such as "Marketing Managers/Directors", "Communications Managers" and in some cases "co-founders/founders".

As of March 30th, 2022, eight companies replied positively to my initial request for an interview. 6 of the companies followed through after receiving the interview questions via email and informed that it was a semi-structured interview (SSI), the questions would be used as a base for discussion during the interview (Flick et al., 2004). An SSI is designed to explore subjective answer from respondents in relation to their experiences or situation (McItosh and Morse, 2015). There was also an option for all the companies to respond in-line via email to the questions sent after a positive response. Of the six that replied to the second email, only three had confirmed dates via a calendly link which had been set up for ease of time scheduling. Calendly (Calendly, 2022) is a free scheduling webtool which integrates directly with the calendars of both parties, it helps to seamlessly find a time which fit both calendars. This tool was used as it was considered the best and most efficient way to arrange a meeting time with companies across multiple different time-zone. two companies were interviewed by the 30th of March 2022 and one company did not show up during the confirmed time. Leading questions for the semi-structured interviews are found in Appendix 1

By March 30th, 2022, two companies were interviewed with times spanning between 35 and 45 minutes. A final request was made on March 30th to the remaining four companies which responded to the second email for an interview time or to answer the questions via email. One more company then confirmed a date for interview for April 20th, 2022.

During the interview process the respondents were asked if the brief of their product was accurate and confirmed their headquarters (Appendix 1). In the interview process, some companies had additional material to share, some of which is referenced in the results and discussion chapters below.

The data is analysed following the theoretical lens introduced in the beginning of this paper. Results are then compiled in a table representing the significant findings from each collection of material stated above.

3.3 Delimitations

There are many applications and services that track a consumer's behaviour and habits which are readily available on mainstream app stores. Health, diet and fitness are among the most common apps that are designed to change consumer habits. To narrow the field of research, apps that are not directly related to consumer carbon impact but are designed to influence consumer behaviour have been excluded. The purpose of consumer behaviour and habit change in this study must be aimed at creating a more sustainable food system which fit the criteria of the theories introduced above and aim to have positive food practice outcomes. While the primary focus is on influencing consumers toward sustainable food practices, companies who have a goal to influence sustainable behaviour as a general term have been included. The discussion chapter of this thesis relates to the impacts these applications might have on creating a more sustainable food system at the consumer level and its implications on a sustainable food system.

4. Results

A summary of significant findings and synthesis of identified consumer tech values from the **literature review** is first presented in this section. The results from the corporate data and interviews are presented in a way which follows the format and structure of the theoretical framework outlined near the start of this paper. **Sustainable Food Systems** and its subheadings, followed by **Consumer Behaviour** and its subheadings. A further section on data collection is added here as both corporate material and interviews alluding to the importance of data in their applications. Papers included in this review **N=13.**

4.1 Literature review:

The narrative literature review compiled papers with different research methodologies and background theoretical perspectives. This review sought to search for papers which were not directly to carbon tracking mobile applications, but rather the influencing factors on consumer behaviour through consumer technology. Synthesis of the results compiled in the papers signify key components of successful influence on consumer behaviour by identifying **Consumer Tech Value** held by the user. Consumer tech values are a mixture of behavioural decision making and intrinsic or extrinsic reward desires. The results of this review highlight findings from eleven of the most significant consumer tech values. A full list of eleven values are presented in Table 3.

Consumers present elements of **hedonism and utilitarian** desires when interacting with mobile applications (Barboza and Filho, 2019) as incentives to drive them toward green consumption. **Hedonism** referring to the happiness, amusement or entertainment a consumer might associate with using the app *(ibid)*. **Utilitarian** mostly referring to the rationality and necessity of using such and app which should be fulfilled during the experience of interaction with consumer technology.

Social Biosphere empower consumers to continue toward actions which are deemed more sustainable and appropriate by the social circles. Referring to a study published by (Moisander, 2008), the authors inform that consumers need to change from individual decision making toward more collective forms of social action (Barboza and Filho, 2019). This in turn is leading to encouragement of close social circles to consider changed consumer behaviour collectively. Finally, **egoist** values relate to personal interest of the user and the motivation of one's own actions.

Further, it is found that **Tailoring actions** in mobile application which can change their messaging, goal setting, and suggestion based on consumer feedback and data collection have been shown to be more effective in many settings than non-differentiated interventions (Kreuter and Skinner, 2000). While this is not a consumer technology value, it is discovered that catering to individuals and their goals rather than generalising actions has a significant impact and will be discussed in the application of consumer technology.

Table 3: Consumer technology applied values

Values	Description	Papers
Green Values or goals	A consumers desire personal values toward more sustainable systems	(Barboza and Filho, 2019), (Samoggia and Riedel, 2020), (Payne et al., 2015), (Bordoni et al., 2020)
Hedonist	Desire for entertainment and happiness through consumer tech	(Barboza and Filho, 2019), (Tang, 2019), (Lee and Han, 2015), (Bordoni et al., 2020)
Technological	Acceptance, readiness, and literacy of tech	(Barboza and Filho, 2019), (Tang, 2019), (Wu, 2013), (Samoggia and Riedel, 2020), (Lee and Han, 2015)
Utilitarian	Functional and rational necessity of the consumer tech	(Barboza and Filho, 2019), (Tang, 2019), (Wu, 2013), (Samoggia and Riedel, 2020), (Wang et al., 2013), (Lee and Han, 2015), (Hanson and Ahmadi, 2021)
Egoist	Behaviour driven by benefits to personal interest	(Barboza and Filho, 2019), (Wu, 2013), (Payne et al., 2015), (Wang et al., 2013), (Lee and Han, 2015), (Bordoni et al., 2020)
Green consumer	Concern for the environment reflected in actions	(Barboza and Filho, 2019), (Roe et al., 2022), (Samoggia and Riedel, 2020), (Bordoni et al., 2020)
Social Biosphere	Focus on social standing, how an individual is perceived by others, existing or changing social norms	(Barboza and Filho, 2019), (Wu, 2013), (Samoggia and Riedel, 2020), (Payne et al., 2015), (Wang et al., 2013), (Hanson and Ahmadi, 2021)
Cognitive Factor	Thought process, intrinsic and extrinsic	(Qin et al., 2021), (Tang, 2019), (Roe et al., 2022), (Samoggia and Riedel, 2020), (Wang et al., 2013), (Bordoni et al., 2020)
Affective Factors	Emotional response, satisfaction	(Qin et al., 2021), (Tang, 2019), (Wu, 2013), (Wang et al., 2013), (Bordoni et al., 2020)
Conative Factors	Consequence of decision making and continuation intention	(Qin et al., 2021), (Tang, 2019), (Roe et al., 2022), (Payne et al., 2015), (Lee and Han, 2015), (Bordoni et al., 2020)
Education	Useful information derived from consumer tech usage	(Barboza and Filho, 2019), (Roe et al., 2022), (Samoggia and Riedel, 2020), (Wang et al., 2013), (Bordoni et al., 2020)

The literature review reveals two key factors which are applicable to the consumer technology and it's potential in a sustainable food system through habit change of consumers. The first being **Behavioural Research** as a component of data collection and background knowledge that should be studied by companies wishing to provide carbon or sustainability tracking applications. The outcome of **Behavioural Research** leads to the second key factor, the identification of **Consumer Tech Values,** certain values must be met by the consumer to achieve successful implementation of the applications. **Egoist, Utilitarian** and **Social Biosphere** are three consumer tech values which appear most frequently in the studied papers. A modified version of the analytical framework Fig 6 highlights the input of background research in behavioural sciences and the discovery of **Consumer Tech Values**.
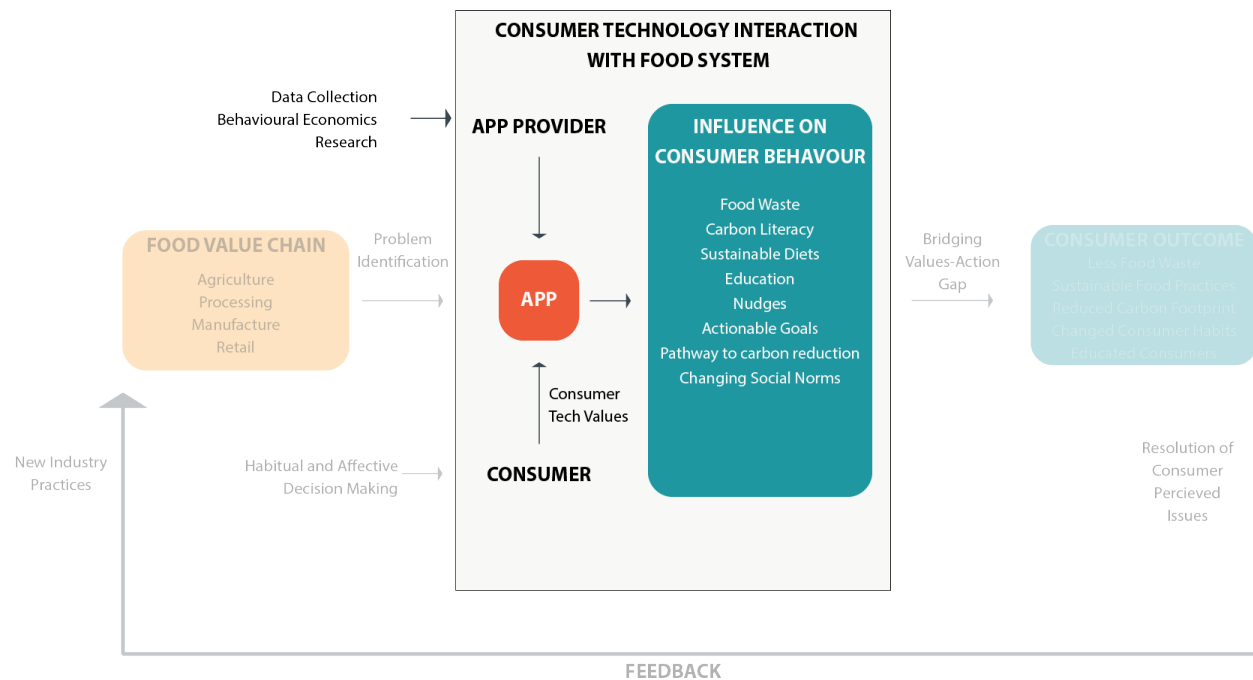

Figure 6: *Application of literature review to analytical framework*

Papers selected in the narrative review have been synthesized in the table below Table 4.

Table 4: Synthesis of papers for literature review

#	Title	Method	Authors	Year
1	Green Consumption values in mobile apps	Netnographic analysis Interviews N=6	Marina Nascimento Lemos Barboza, and Emılio Jose Montero Arruda Filho	2019
2	Randomized Controlled Trial to Address Consumer Food Waste with a Technology-aided Tailored Sustainability Intervention	Randomised control trial N=44	Brian E. Roe, Danyi Qi a, Robbie A. Beyl, Karissa E. Neubig, John W. Apolzan, Corby K. Martin	2021
3	A systematic literature review and analysis on mobile apps in m-commerce: Implications for future research	Systematic literature review N=84	Ailie K.Y. Tang	2019
4	An integrated framework of mobile apps usage Intention	Literature review	Hsiu-Lan Wu	2013
5	Assessment of nutrition-focused mobile apps' influence on consumers' healthy food behaviour and nutrition knowledge	Sampling of users N=143	Antonella Samoggia, Bettina Riedel	2018
6	Behavioral Functionality of Mobile Apps in Health Interventions: A Systematic Review of the Literature	Literature review N=24	Hannah E Payne, Cameron Lister, Joshua H, Jay M Bernhardt	2015
7	Consumer mobile health apps: Current state, barriers and future directions	Narrative review	Cheng-Kai Kao, David M. Liebovitz	2017
8	What Affects Mobile Application Use? The Roles of Consumption Values	Structural Equation Modeling N=282	Hsiu-Yu Wang, Chechen Liao1 & Ling-Hui Yang	2013
9	Determinants of adoption of mobile health services	Interviews N=550	Euehun Lee and Semi Han	2015
10	Can we promote sustainable travel behaviour through mobile apps? Evaluation and review of evidence.	Literature review of BCSS	Varsolo Sunio, and Jan-Dirk Schmocker	
11	How mobile augmented reality applications affect continuous use and intentions: A cognitive-affect-conation perspective	316 Users interviewed (PLS-SEM)	Hong Qin, Babajide Osatuyi, Lu Xu	2021
12	Mobile applications to reduce food waste within Canada: A review	Literature review	Victoria Hanson, Latifeh Ahmadi	2021
13	Data on the potential of nutrition-information apps from a consumer behaviour perspective	Survey N=143	Antonella Samoggia, Alessandra Bordoni, Francesca Monticone	2020

4.2 . Results company data and interviews

This section represents the findings from interviews conducted with the companies that were included as part of the case study. As each company had a slight variety in the questions asked, the results section is presented in a way that matches the theoretical framework. Findings are elaborated on in the discussion chapter to follow. Data and information sources such as whitepapers, methodologies and research papers were most reliable for the purpose of this results section. This results section highlights tactics used by the six companies included in this study and categorizes them within the theoretical framework introduced earlier in the paper: **Sustainable food systems** and its subheadings followed by **Consumer Behaviour** and its subheadings.

4.2.1 Sustainable Food Systems

One of the largest areas of impact these mobile applications may have on the sustainable food system is in the education of a consumer's food choices or practices. Giki (Giki, 2022) find that within their consumer base of over 12,000 active users, food practices account for up to 35% of an individual's yearly carbon footprint. In an interview with a New Zealand based company, CoGo, Josh Dry iterates that mass adoption of sustainable activities will help to drive change down the value chain to hopefully encourage a more sustainable system (Dry, 2022). Several companies noted that they would like to be able to track purchases from supermarkets at an SKU (stock keeping unit) level. Currently, carbon and sustainability tracking apps are able to distinguish that a consumer has used a certain food retailer but are unable to track which specific products they purchased. The same companies report that they would be able to provide much more specific and accurate feedback for a consumer's carbon emission if they had data on the products being purchased. This level of data collection extends to all purchases from retailers which might have multiple types of products – for example, a supermarket has products from all around the world and the consumer may be purchasing sustainably grown produce, or they could be purchasing imported meats. Whereas a consumer logging a purchase at a petrol station is almost certainly spending most of the money on petrol for transportation – a carbon tracking app can assume with relative accuracy that the purchase can be logged as petrol and calculated accordingly.

Sustainable Diets

CoGo has experimented with trying to push people to go vegan, a diet which is considered to have a much lower carbon impact due to cutting out animal products. There has been some significant pushback which is likely due to the extreme change that might be required. New Zealand has a food culture which typically embraces meat several times a week, if not multiple times a day. CoGo have recognized that to get people to change their diets they need to encourage smaller steps such as "meat free Mondays" and have consumers take part in these smaller actions first. A sustainable diet does not only have benefits to the environment, but they are also typically healthier for the individual which is a key component within both a sustainable food system and sustainable diet.

Like estimates on food waste or any carbon emitting activity, companies with carbon or sustainability tracking apps can only make blanket estimates which average a consumer's habits. These estimates are often applied at a region or at least country level with data being used from local authorities, FAO or nutritional survey data. For measurements and influence on consumer diets, some companies such as Giki (Giki, 2022) have made a variety of choices, such as "no red meat" or "vegetarian" which will include or exclude typed of food depending on the consumer input. Giki also uses a calorie neutral approach which assumes that the consumer is eating as many calories as they would burn (Earth, 2022). These combinations of foods or diets have their CO_2 (Carbon Dioxide) emissions calculated by using academic meta studies. The data collected from the meta studies can then be combined to make a framework which can be applied to the foods and inputs given by the consumer to gain an accurate estimate of their emissions depending on their food intake choices.

Consumer Food Waste

Food choices and practices are directly considered in most the companies synthesized in this study. Consumer food waste is identified and recognized as a relatively high impact activity in terms of an individual's carbon emissions. Some ways in which these applications are striving to reduce a consumers food waste is by helping to calculate their wastage and put it into an understandable perspective. Putting carbon emissions into a perspective that can be understood or even tangible has been an effective way to educate a consumer. This is achieved by either showing an individual's food waste as a percentage of their total carbon budget or emissions – Decarbon (DecarbonApp, 2022) along with several other products allow the user to set their carbon emission goals. Decarbon recommends a goal of 7 tonnes of CO_2 per year per person, this is based off an analysis set by Carbon Brief (Brief, 2022). The user will then see how much of their allocated 7 tonnes is being used by food waste. Other companies have set different standards and goals for an individual's carbon emission goal (per tonne) the lowest recommending 1.5tonnes.

The ability to calculate or estimate a consumers food waste is difficult as there are large variations depending on multiple factors ranging from the country, infrastructure and social norms. Giki (Giki, 2022) uses sources such as Defra, world bank and WRAP to give accurate estimates on household and consumer waste data. Similar to their approach to diet choices, Giki uses meta studies to average the consumer waste depending on their diet input. Most companies allow the user to set goals or campaigns related to reducing their food waste. Reduction in food waste is an small actionable step where a consumer can quickly change their behaviour to see results.

4.2.2 Consumer Behaviour

The values-action gap is one of the largest factors which is limiting many customers from reaching their full carbon reduction potential according to several of the companies included in this case study. A consumer may understand the importance of making a change to their carbon producing activities but do not know the best way to go about it or struggle to make the first steps. It is important for the companies to understand behaviours and habits to make timely and significant changes. Companies can begin to have a deeper understanding of consumer behaviour by looking at historical data. The products which are able to import and utilize historical data will gain valuable insight to the kinds of behaviour that their customer is inhibiting. Through this data they can then more effectively make suggestions which are well suited to the customer.

As it is currently difficult to have exact data and information down to the product level of consumer purchases (for example the applications knows that the consumer has made a $30 purchase at a supermarket but does not distinguish the specific items), most companies involved with carbon or sustainability tracking apps instead try to alter general purchasing habits and behaviour. Joro (Joro, 2022) , like most of the other applications understand that they must make their best estimates and then help the consumer understand their most important leverage points for impact.

> For instance, instead of comparing the footprint of one brand of beef to another, we reveal that the choice of chicken over beef is the one you should be relatively more focused on (Joro, 2022).

As identified by CoGo in the Sustainable Diets chapter above, encouraging a consumer to make radical changes to their diets or habits can be seen as confronting or discouraging when the leap seems too far away. In the case of Joro's example, a small change in consumer behaviour while still maintaining some intrinsic and heuristic thought process (buy meat) may have high chances of success.

One company, Giki has a three stepped approach to changing consumer behaviour, they refer to it as the 3Rs – Reduce, Replace, Repair (Hand and Carmichael, 2020). **Reduce** encourages an individual to cut back on carbon emitting activities such unnecessary food waste, avoiding unnecessary consumption or cutting back on fossil fuel intensive transport. Giki estimate that a single consumer can already reduce two tons out of the typical nine tons of carbon emissions per year by using their reduce steps. **Replace** is the act of replacing goods and services with lower carbon emitting alternatives, such as renewable energy sources, changing to a more plant based diet or divesting from fossil fuels. Finally, **Repair** are actions which encourage the user to take part in restoring eco systems and removing carbon, these encourage steps which actively help the environment but might take a long time for impacts to take place – such as planting trees which sequester carbon at significant rates many years after they have been planted.

Transparency is a key component to ensuring the consumer can trust and validate their carbon emission due to their actions which are reflected on an app. Decarbon has their model and information as open source as a way to show transparency but also to encourage other developers to track carbon emissions (Graycar, 2022). Giki also allows for full transparency by siting all of

their data and sources which can easily be accessed by a user. A user who can self-validate and confirm data sources is more likely to trust the information being presented to them by the apps.

Decision Making

CoGo introduces a term in their white paper called Carbon Literacy (Langlands et al., 2021) a phenomenon which often prevents a consumer from correctly identifying high carbon impact actions. This indicates that people might put more emphasis on visual activities like recycling or not littering which have a relatively low impact, compared to choosing to eat less meat since they have no way of seeing their direct impact in their choices.

> *For example, littering creates no emissions, yet researchers found that people estimated the impact to be roughly equivalent to a high-pollutant flight across the Pacific Ocean* (Langlands et al., 2021)

Increasing a consumer's Carbon Literacy suggests that it would help the consumer in closing their values-action gap as they can more easily identify decisions which would lead toward more effective and sustainable behaviours.

As many heuristic decisions are made due to societal norms and habits developed by the consumer, the companies with carbon tracking apps are working to help change or challenge the social norm to get their consumers to make easier and more sustainable decisions.

Giki and several other apps use graphics to help illustrate a consumer's carbon footprint, being able to put perspective and comparisons on their actions is one of the ways in which these products work to help a consumer make a more sustainable decision. All of the apps included in this study offer the consumer a decision to make automatic or manual carbon offset contributions to projects selected by the application. From the data collected from whitepapers and interviews, we find that consumer's are likely to participate in carbon offsetting initiatives for two reasons. The first is being able to see and understand their carbon emissions, the second being to help reach their goals set by the user or by the application.

> *...people can gain an understanding both of the size of their carbon footprint and also how it breaks down. This gives them important information to think about where they can focus to make cuts (Hand and Carmichael, 2020).*

Making decisions with a sustainable outcome is also helping customer's to achieve other goals which in turn helps keep motivation high. Cross-goal achievements and desires may include saving money or getting in shape. Joro reports that their average user saved $3,300 in the year of 2021 (Joro, 2022).

Gamification

Almost all the companies are using some elements of gamification to drive engagement and motivation with their customers. Gamification has proven to be a great way to keep the engagement high with the consumers. One of the more common tactics being used is a leaderboard where the user can see how their actions or activities measure up against other users. Several companies are able to show how many users are involved in a certain campaign, this combination of leaderboard and nudge (see below) have proven to be very effective ways for the consumer to stay motivated, make more sustainable decisions and close the values-action gap. As identified by several companies, allowing the consumer to see their direct impact or how they fit into the grand scheme is one of the biggest motivating factors for the user to continue a low carbon emitting activity. In the case of a leaderboard and showing how many people are involved in a certain campaign or action, the consumer can see a shift toward a new local social norm which embraces sustainable activities. Joro finds that user who have followed at least one other person on the application had carbon emission saving of 20% more than those who did not follow anyone (Joro, 2022).

Beyond developing a new norm within a community, gamification has allowed for new levels of team building in cases where an entire enterprise or organization might be using an carbon tracking app. Setting goals and challenges within the mobile app which are utilizing gamified elements such as leaderboards and competitions are developing new ways of encouraging sustainable activities within the workplace. According to Giki:

> *…pledging to a goal gives people a simple way to start, ensures they feel part of a wider collective action and sets a timeline to encourage action not procrastination (James Hand and Carmichael, 2020)*

JouleBug (JouleBug, 2022) is one of several companies that have developed a product specifically for enterprises which aims to set an entire team of people working together to achieve sustainable goals. JouleBug *(ibid)* allows companies to set their own sustainable and achievable goals they believe that seeing others around you achieve their goals is the perfect motivation (Enterprise, 2022). Beyond gamification elements to encourage low carbon emitting behaviours, Apps apply their techniques to general health and lifestyle actions which continue to encourage a shift in behaviour using gamification. Some of these categories include: fitness – promoting health beyond diet, civic – encouraging action which has the user becoming more involved with their communities and, diversity & inclusion which its constantly encouraging an individual to gain new perspectives or try new things to reevaluate their biases (JouleBug, 2022). All of these categories follow a similar structure within gamification, there is an ability to create or join challenges, leaderboards and a social element which allows an individual to interact with others who are participating in the same categories. A social identity within a community or system has also proven to be an effective way for consumers to feel as if their decisions and behaviours are making an impact. While it may be difficult for an individual to feel as if their smaller actions – such as dropping meat on Mondays, has much of an impact, when they can see that they are part of a group or community of people that are involved in the same actions, there is a better chance that they will feel positive about their emissions reducing activities.

Table 5: Examples of challenges, campaigns or dares set by companies

Company	Example Campaign/challenges or dares
Cogo	Meat-Free Mondays, vegetarian diet, no dairy in groceries, vegan when eating out
Giki	Plant Based Diet, Plant trees, Share unused food, No food delivery
Joro App	Vegan/Vegetarian/Pescetarian for a week, Conscious eater
Decarbon	No Meat, Plant trees
Ailuna	Meatless week, wasteless lunch, plastic free tea, refillable water bottle
JouleBug	Meatless Monday, Silver Spoon (bring your own cutlery), Pack a Snack, Feed the worms

Nudging

All apps included in this study use a form of nudging, primarily in the form of timely notifications. One company, CoGo has developed their own Ethical Nudge Framework (ENF) which depicts a non-linear journey in a consumers decision making process and progress toward more sustainable actions. FIG 7 (Permission granted by CoGo). The app has a product that is focused on the individual consumer level, nudges play an important role in motivating sustainable behaviour. These nudges (or alternatively boosts in CoGo's model) are tactics used to remove barriers for the consumer to normalize more positive and carbon friendly behaviour. In the context of consumer facing mobile applications, nudges are sensitive to time and information. Cues are internal or external prompts, something that can be in a physical environment or if it is internal, something that triggers the way one already feels or thinks. Cues can be used in the form of push notifications which in turn nudge the consumer toward a more desirable behaviour. For example, a notification at 11am suggesting the user goes to a local café for a vegetarian lunch proves to be more effective than that same message arriving hours before or the day before. Positive reinforcement messaging has also proven to be far more effective than messages which shame or recognize negative behaviours as this can trigger both action and climate anxiety (Dry, 2022).
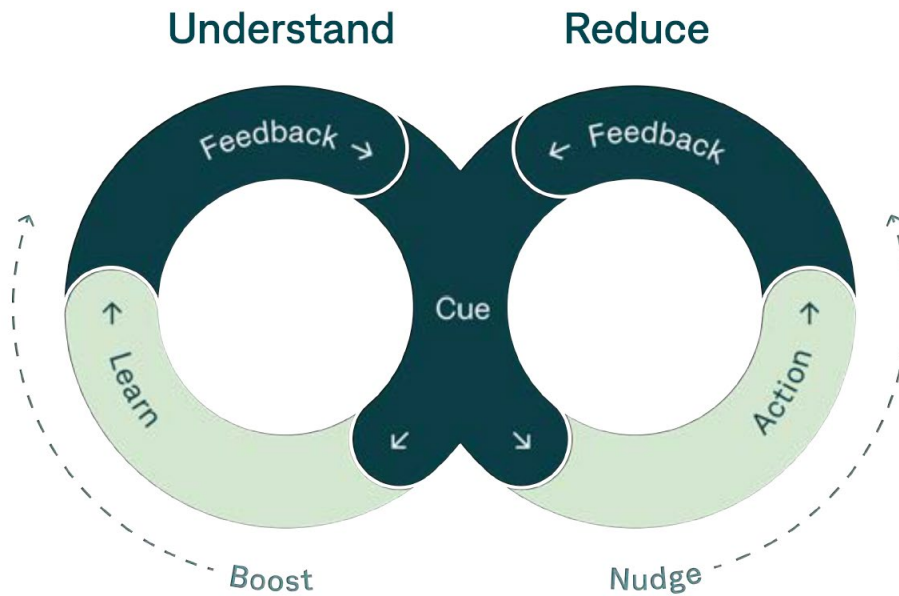
Figure 7: CoGo Ethical Nudge Framework (ENF): Permission granted by CoGo April 2022

The model above illustrates CoGo's Ethical Nudge Framework, utilizing elements of gamification and behavioural sciences to encourage climate action with their users. The model is non-linear which shows the users journey between the '**understand**' and the '**reduce**' loops. Understanding the users journey allows the company to design effective value-led solutions to help consumers close their values action gap and achieve their climate goals. Starting with a '**cue**' positioned between the 'understand' and 'reduce' loops, cues are prompts that mobiles apps use in the form of push notifications. '**Learn**' is the application of education through tactics employed by the company to increase carbon literacy. '**Action**' are the steps that the users take to actively reduce their GHG emissions. '**Feedback**' is encouraged to further cater toward an individual user's needs and goals, this is common amongst companies included in this study. Lastly, the '**Nudge**' to steer people toward their climate goals can be utilized in a gamified way by showing the user how their purchases compare to others within a specific campaign or by suggesting more carbon friendly businesses offering similar products.

4.2.3 Data Collection and Input

Data collection and input to the application come primarily from two sides. The first is from the backend, or company side. To achieve this, multiple sources must be reviewed in order to return accurate information to the user. Companies like CoGo, Giki and Joro have teams dedicated to data collection which work to find accurate information on broad carbon emissions caused by certain products or industries. As the companies primarily work in differing countries, the available data and metrics are slightly different, information and statistics are collected from national environmental data sets which have estimates of GHG emissions across multiple sectors of a country. In most cases, input-output models will rely on financial data to estimate carbon emissions in relation to the background data collected by the companies or financial institutions. This works by issuing a formula which calculates carbon emissions per dollar based on the industry in which the purchase occurred. Financial based carbon estimation allows for quick analysis of alternatives or trade-offs across spending categories – for example, the user can quickly see their estimated carbon emissions spent in the food category compared to transportation. Discovered in the interviews and reading available sources from the companies included in this study, it is evident that these apps would like to be able to have process-based collection to represent data at an SKU (Stock-Keeping Unit) level for a wider range or products. Most companies are able to use some level of process-based data collection but are primarily input-output based. User input is easily collected when the app can connect to financial institutions so a purchase is automatically recorded and processed when a consumer has a credit or debit card linked to their account. Users are able to manually input changes or corrections to their recorded purchases, this allows for the apps to take into account instances where the input data from the financial institution is incorrect or if a consumer makes a purchase for someone other than themselves (for instance, buying a meal for two).

Table 6: Data collection and carbon offsetting or food partnership examples

Company	Data Sources for emission calculations (examples)	Carbon Offsetting and Food Partners (examples)
Cogo	GIF (Good Impact Framework), Motu, SWC, IeLab	South pole, Green Collar, Carbon Click NZ
Giki	National Energy Efficiency Data, EIA RECS, UN, Eruostat	Treesisters, Eden Project, Tree Nation
Joro App	CIFT-US, USEEIO, Plaid, EIA	Charm Industrial, Running Tide, Nori, Grassroots Carbon, Pachama, NCX
Decarbon	Carbon Brief	Patch, Salto Pilao Hydroelectric, Husk, Charm
Ailuna	In-house Behavioural Sciences	Big Barn, Slow Food, Carbon Trap, Verra, Rebalance Earth
JouleBug	In-house Behavioural Sciences and Gamification	Set by company participants

Through triangulation of data compiled of a narrative literature review, semi-structured interviews and an assortment of corporate material, the results have been structured to reflect the format of the theoretical framework. The narrative literature review confirms that behavioural change tactics are used with consumer technology and more specifically mobile applications. Tailored interventions to the consumer prove to be an effective way to keep an individual engaged and on track with their desired outcomes. Corporate material illustrates that breaking down actions into categories allows the consumer to gain more detailed insights directly related to their actions within a specific area of their lives. Vegetarian diets or diets with less meat are common amongst goals set by the carbon tracking applications as they are achievable for the consumer and have a significant impact on ones carbon emissions within their food practices. Interviewees state that being able to put carbon emissions into an understandable perspective have been valuable ways to influence consumers toward more sustainable habits. Along with perspective of their emissions, continuous education toward carbon literacy and using positive reinforcement have better results than highlighting negative actions or behaviour. The table below Table 6 synthesizes the triangulation of data, highlighting the important findings in a categorical order consistent with the theoretical framework and triangulation method, with an addition of data collection/input methods.

Table 7: Summary of results

	Literature review	Corporate material	Interviews
Sustainable Food Systems	• Up to a third of food is never consumed • Technology-aided sustainability interventions connect with the last link in the food chain – the consumer. • Food waste on the household level is influenced by many factors including community and social standards. • Apps can be used to offset or replace human touchpoints and interaction	• Actionable steps encourage users to create more sustainable food habits. • Apps breakdown actions to at least food purchases and food waste. • Setting food goals is a great way for a consumer to start reducing their carbon footprint. • Vegetarian diets or diets with less meat are common amongst goals as they can significantly drop consumer carbon emissions	• Food can have a major impact on an individual's carbon footprint. • Visualising data and putting food choices into perspective help a consumer to understand their impact. • Sustainable food purchases tie in closely with healthier diets, used as a motivating factor. • Household food waste is a source of carbon emissions that are quickly easy to eliminate.
Consumer Behaviour	• Tailored interventions have proven to have a significant and lasting impacts on a consumer's habits. • Behavioural change challenges or targets according to the consumer's desire and outcome goals have best success rates. • Social, utilitarian, and egoist values or motivations are important in the success of consumer technology-driven behaviour change.	• Instant feedback allows the user to quickly gain a better understanding of their carbon impact. • Putting actions into perspective allows for deeper understanding is a challenge. • Creating a social environment for interaction with help with consumer engagement, meaningful changes and decisions.	• Users need a way to understand the impact of their actions. • Many people taking small steps will create significant changes. • Small and achievable goals motivate users • Seeing several people involved in certain campaigns builds a sense of community while helping to create new social norms
Data Collection and Input	• Random selection participants • Control groups across several countries. • Systematic reviews	• Process based collection requires far more investment of time and resources, • Difficulty in data as LCA reports may vary depending on the research institution. • Financial spending data is currently consistent with footprinting standards across multiple industries though they may vary per country.	• Process-based collection is highly desirable but many challenges. • Large amounts of human resources and finances are required to obtain accurate and trustworthy carbon emission data at a SKU level. • Users can edit data to receive more precise feedback on their carbon emissions.

5. Discussion

This section discusses the findings from interviews and additional sources of information gather which were presented in the results section above. Beyond the theoretical perspectives which have been introduced in this thesis, this discussion section will also include some of the challenges and future opportunities for companies providing carbon or sustainability tracking apps. Further, this section discusses the implications of consumers using these products in the context of a sustainable food system with the goal of a consumer developing more sustainable habits with their food choices.

5.1 Sustainable diets and food system

Users of the carbon or sustainability tracking apps included in this paper can set food goals, accept challenges or join campaigns that are directly related to their desired outcomes. Within a sustainable food system, the value chain does not end with the consumer and household waste. It also recognizes that within a systems thinking approach, there are many sources which influence a specific outcome anywhere along the chain (IFST, 2018). Consumers have choices to either reduce their waste or go on to compost and responsibly dispose of their food. The apps encourage the consumers to actively think about their interaction within the food system by evaluating their diet choices, purchasing locally or imported and how to reduce their waste, or compost their uneaten foods. Referring to the conceptual, analytical model introduced in the theoretical framework, consumer technology in the form of a mobile application can influence the consumer to address food systems issues from a systems thinking perspective. Evidenced in the results from the literature review, corporate material, and interviews consumers require incentives which satisfy their values, especially regarding **Hedonic, Egoist, Utilitarian and Social Biosphere.** With reference to the Theory of Planned Behaviour (Ajzen, 1991) and consideration of the principles associated with the key values – there is a symbiotic relationship in which the most important consumer technology values match the identifying factors of Ajzen's theory.

Sustainable diets are typically healthier for the consumer and the entire food system. Recommendations and steps toward a more plant based and local diet are prevalent in all of the apps included in this study. This added benefit of a sustainable diet being more beneficial for the consumer is a good way to motivate an individual to be more conscious about their food purchases. Giki state in one of their research papers that going plant based will also help the consumer save money while improving their health outcomes (Hand and Carmichael, 2020). Through more sustainable food purchases alone, an induvial might be able to reduce their carbon emissions by 1 to 1.5 tonnes per year.

5.2 Education and carbon literacy – how do people view the impact of their actions?

Consumer based technology has potential in educating and influencing consumer behaviour within a sustainable food system. Through techniques used to educate the consumer, a user may begin to exhibit a more extended (vs limited) (Young et al., 2009) and cognitive (three buckets of decision making) (Solomon et al., 2016) thought process toward their food practices. In both the IFST and Ericksen's food systems that rather than just a linear chain from production to consumer, sustainable food systems are complete with feedback loops and intervention on many levels and to varying degrees. Consumers may have issues with finding reliable and accurate information regarding their purchasing decisions and actions. Two major challenges are giving the consumer access to the information, and the other challenge is having the consumer understand the sustainability outcome of their actions.

Carbon tracking apps have an opportunity to express and illustrate the CO2 emissions from their actions. As all the apps can categorize food behaviours, a consumer can quickly determine their daily or yearly carbon emissions expended by their food choices. Rather than just exposing the consumer's carbon emissions as a number (in weight), the apps show their comparisons to other activities such as transport or electricity. This is one of the ways in which the apps have successfully been able to educate a consumer on the impact their food practices. Beyond comparisons, most of the apps also use some form of nudging, often by sending well timed notifications to their phones. For example, CoGo uses their ethical nudge framework to send a timely notification to a user an hour before lunch to encourage them to try to eat from a local store or to go vegetarian. The nudges are catered to the user as they have already put their information and input regarding their food diet preferences and goals. Positive reinforcement has proven to be a better way to influence a consumer toward sustainable change better than shaming or guilting. Highlighting negative habits has shown an increase in climate anxiety with users of carbon or sustainability tracking apps.

5.3 Changing social norms

In the context of (Young et al., 2009) and their research which looks at Limited vs Extended decision making, they indicate that a consumer looking to make more sustainable actions will have a more extended thought process. Carbon tracking and sustainability apps are utilizing techniques within gamification and nudging to shorten the thought process and take advantage of heuristics. An individual relying more on social norms, heuristics and affective decision making will be able to partake in more sustainable activities naturally and subconsciously. The community aspects of the applications contribute to changing social norms while increasing carbon literacy and it allows the users to compare to national averages or their peers. Gamification tactics utilized by companies providing carbon tracking apps has been one of the most effective ways to help create new social norms around sustainable food practices. In a published review by (Joro, 2022), a user connecting with just one other person on their app would lead to a 20% reduction in carbon emissions and have an impact on their financial savings. During interviews, both CoGo (Dry, 2022) and Ailuna (Ronning, 2022) reported similar benefits toward an individual when they are able to connect and become part of a community oriented goal (campaigns and dares).

A cognitive thought process as introduced in the theoretical framework (M. R. Solomon et al., 2016) is a more deliberate, rational and sequential approach to decision making. Companies with carbon or sustainability tracking apps are encouraging users to take this approach by educating the consumer/user with data based off their actions. Whether the applications have integration with banks/financial institutions, so their data is automatically included off every purchase from their credit card, or if the user must input data on their own, there is a level of feedback which results in the consumer reflecting on their decisions. Mass consumer technology uptake by consumers and implementation of tactics which lead many individuals toward more sustainable habits will have an impact on social norms. One of the keys to the success in this tactic is to show users how they measure up against other consumers without degrading or creating anxiety if they are underperforming (Dry, 2022). Discovered in the narrative literature review, the **Social Biosphere** is an important factor and highly rated consumer technology value communicated by the user. Suggesting that applications need a social element in their design to increase user satisfaction and retention.

5.4 Gamification success and possibilities

It is important for users to see how they fit in within a group goal, it has been established that it requires many consumers to make larger scale, meaningful changes. A goal is a very quick and easy way to get a consumer to make a pledge toward specific actions, being part of a team goal helps the consumer feel as though they are part of a wider, collective action with ability to make a positive impact. Through interviews and data collected from online reports, we find that consumers are empowered when they can see their relative impact within a group setting. One simple gamification technique being used by all of the apps is some variation of a scoreboard or leaderboard. Scoreboards have been highly useful for the individual user as they can quickly see and understand where they have the greatest emissions. Leaderboards help create a sense of competition in which some people feel more motivated to engage to claim a top spot. There is potential of a leaderboard creating some levels of discouragement, though most companies have found that the benefits of a leaderboard are greater than any detriments. A campaign setting is a great way to encourage small steps or changes in consumer behaviour which outline achievable goals that lead to more sustainable actions. This has proven a good way for the companies to influence changes in behaviour that initially have a relatively low impact. As in a sustainable food system, opportunities to reduce carbon emissions must be accessible equitable. Nudges and gamification must be used in way that considers local communities and their ability to make reasonable changes. Setting unrealistic challenges or goals may further perpetuate climate anxiety by the consumer. An issue introduced within gamification by (Mulcahy et al., 2020) states that economic incentives have a far bigger drive than issues such as pollution reduction or in this case, carbon emission reduction. Gamification within these apps helps to overcome this drive for motivation by helping to pave a way to close the value-action gap. Many and frequent actionable steps along with the ability to create community have proven to be effective tactics in leading a consumer toward more sustainable food practices.

5.5 Consumers being the driver for change (power in numbers)

Encouraging more consumers to download and use carbon and sustainability tracking apps helps to empower the individual to take more action. JoroApp reports over 20% decrease (Joro, 2022) for an individual's yearly carbon emissions when they follow at least one other user on the app. CoGo's campaigns actively connect their users together and show a collective score in the reduction of CO2 emissions. While a consumer may be one of the last stages within a food value chain, many consumers striving to make a difference with their food practices has a potential to increase the demand for less carbon or greenhouse gas intensive food products. Following frameworks, challenges or campaigns set by applications give the consumer a clear path to help reduce their carbon emissions or even reach net zero if they have such goals. While many consumers together will have a significant impact on GHG emissions, governments and companies still need to respond to consumer demands for low carbon products and services. Policy, frameworks, and incentives should be introduced to encourage companies and governments to continue to support change toward more sustainable habits within society.

The data and models we develop to inform these recommendations can also be used to inform companies and governments of high-priority opportunities to decarbonize their products and services, facilitating an economy-wide transition to a decarbonized world. (Pal et al., 2022)

In the conceptual model illustrating consumer technology in a food system a positive feedback loops exists which implies resolution of existing food system problems driven by action and behaviour change by the consumer. Mass adoption of consumers changing habits, closing their values-action gap and using a cognitive approach toward their decision making has the opportunity to drive change away from unsustainable industry practices.

5.6 Carbon offsetting

Carbon offsetting is a function that all the applications offer. Consumers may be overwhelmed when they initially learn of their climate impact due to their food choices, along with other daily activities or habits. Carbon offsetting allows the individual to directly contribute to projects which sequester carbon thus essentially giving the individual credits in their carbon score. While carbon offsetting has its benefits for the environment, the ideal goal is to reduce carbon emissions rather than aiming to sequester carbon being emitted by human actions. Average consumer in a middle-high income country has around 9 to 13 tonnes of carbon emissions per year. Food practices account for around 25-40% of a consumer's individual carbon emissions. Achievable reductions might be around one tonne per year for common individual food practices. Further reductions occur when a consumer is able to contribute to carbon sequestering activities such as planting their own fruit trees or growing their own vegetables in a garden. Leading consumers toward self-active carbon sequestration by planting trees may be an effective way to reduce consumer CO2 emissions As carbon offsetting may not be a typical action within an individual's regular activity, it could be a good application to begin moving a consumer toward a more extended (Young et al., 2009) and cognitive (Solomon et al., 2016) thought process which lead to more sustainable decision making with their food practices.

5.7 More accurate data collection

There exists a lack of accuracy with per dollar carbon emissions which is currently the most common way for carbon tracking apps to illustrate a consumer's carbon emissions. For example, all coffee shops will be credited the same, yet one coffee shop may be serving locally grown with sustainable milk alternatives and the other is all imported beans with important animal-based milks. The consumer misses out on accurate information due to their decision to purchase from a local store instead of a international chain with much higher carbon emissions. Manual input is a way to offset this discrepancy and can allow the user to accurately reflect their decision to go local. A bottom-up/process-based approach could offer a lot more accuracy through the use of LCAs (Life Cycle Assessments) to account for the multi-faceted inputs for a product. A process-based approach would allow for much deeper understanding of a consumer's purchases and thus pave the way for an application to provide more accurate results along with better catered recommendations for the individual user. In the input-output model which most apps use as their primary source of data collection and results, it could not distinguish between a meal at a restaurant that sources only local produce compared to a restaurant which serves imported meats and dairy products. Two users which have gone to one of the aforementioned restaurants each and spend the same amount of money would end up with the same carbon emission score reported on their profiles in the input-output model but would differ drastically in a process-based model. Some of the major challenges faced by carbon tracking applications implementing a process-based method are the amount of data and accuracy of the data. LCAs require a very large amounts of data to present complete information for a single product. Collection of data across multiple industries is not only costly but would require participation from multiple stakeholders providing access to information that might be proprietary or they may be unwilling to share.

This issue is also recognized in the IFST sustainable food system introduced in the theoretical framework. Sufficient and accessible data would enable food producers and consumers to better understand the food product, its origin, ingredients, and logistical history (IFST, 2018a). The paper illustrates the difficulty in data security associated within a food system that is increasingly interconnected *(ibid)*. There is potential and perhaps a need for open-source information and transparency for accurate reporting to occur within the food system and importantly to the consumer via consumer technology.

Considering the findings and discussion points of this paper to the proposed analytical model, key areas are identified where the sustainable food system and consumer behaviour theories are applied FIG 8. Starting with the importance of accurate data collection and behavioural economics research, the mobile apps will have the opportunity to reflect **accurate consumer data** and **tailored** nudges, notifications, or goal setting. **Consumer Tech Values** are identified and require attention to retain continued use while providing **hedonic** motivation to potentially create more cognitive and extended thought processes. Bridging the values action gap is achieved when the user has a clear pathway to act on their values, **education** informs the consumer on which actions to take to meet their **values**. Extended outcomes are identified, **new social norms** are developed when **social biosphere** values can be met, allowing the consumer to view their changed habits and outcomes on a larger scale than just a slight reduction in individual GHG emissions. **Carbon offsetting** being a feature of the applications gives the consumer more opportunity to have a positive impact and potentially reduce carbon anxiety, especially if carbon projects are enhancing or growing a food system. Lastly, **consumers driving change** to provoke new industry practices has been identified as a possible feedback loop for continuous improvement and sustainable change within the food system. Fig 8 below, highlights the findings from this discussion chapter and their place within a sustainable food system.
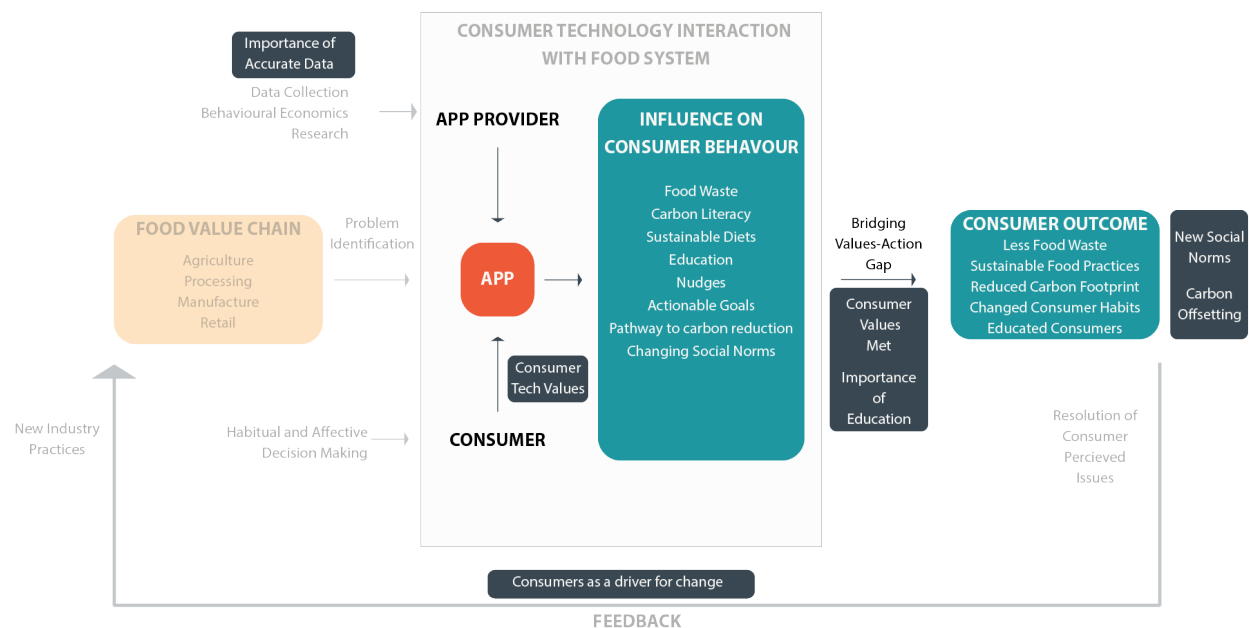

Figure 8: Discussion applied findings to the analytical model. (Own conceptualization)

A final and simplified version of the analytical framework is presented here (FIG 9). Findings in the results from the data triangulation and further exploration within the discussion leads to a consolidated version of the analytical model. Inputs from the app provider focus primarily on data collection and behavioural science research which considers the decision making and values from the consumer. Research suggests that if consumer decision making habits, sustainability values, and consumer technology values are met, there is an opportunity to close the consumer's values-action gap and create new sustainable food practices. New sustainable consumer outcomes may be explored further as a driver for change toward new industry practices throughout other key areas of the food value chain.
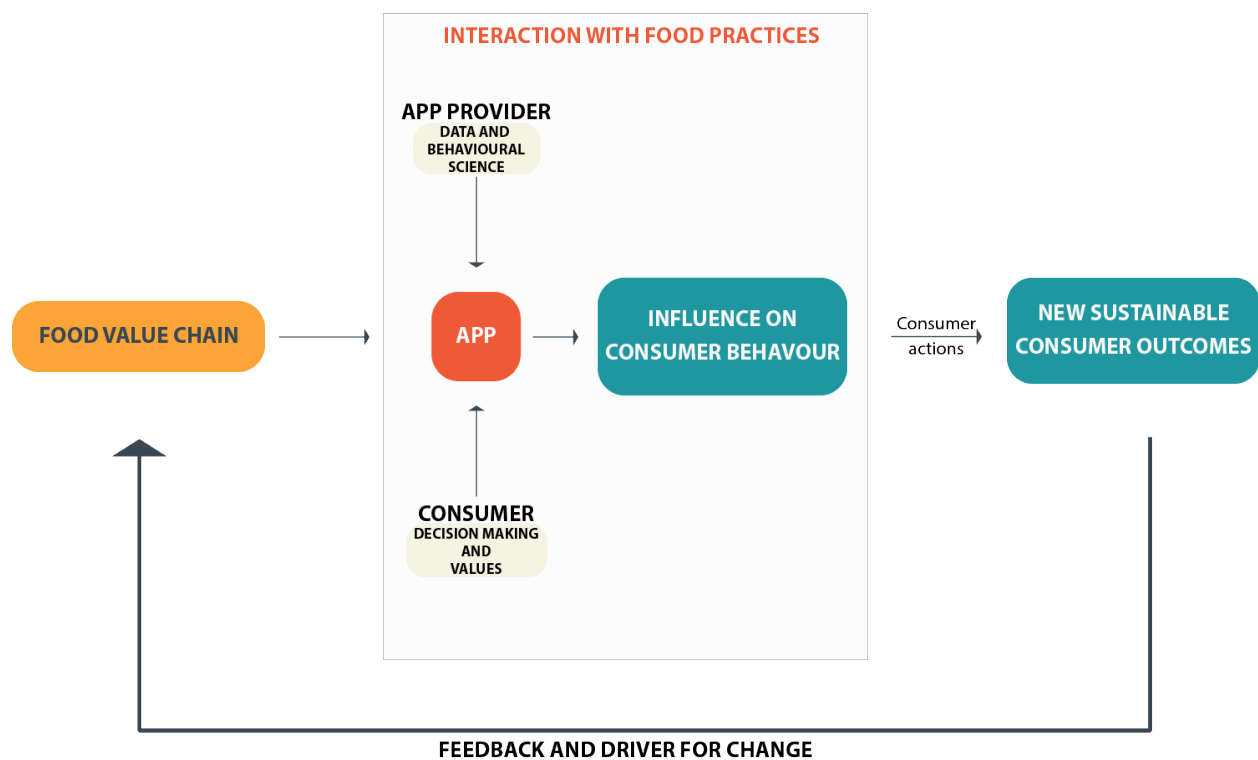
Figure 9: Simplified conceptualization of analytical framework (own conceptualization)

6. Limitations and future research

Data was collected from companies that are currently operating and offering consumer technology with their carbon or sustainability tracking apps. With a qualitative approach, this study does not research the efficacy of these apps from direct consumers. This study has a focused approach on the drivers behind consumer behaviour which may be utilized to build more sustainable food habits. A quantitative study interviewing active users of these apps may be an appropriate way to gauge the success in long term behavioural change instigated from using the technology. A third party, unbiased approach to collecting data directly from consumers may lead to accurate insights which companies could find valuable in the future development of their technologies and provide better methods of influencing consumer behaviour.

A literature review to gather data on the impact that mobile applications have on consumer behaviour allowed for background information, key topics, and points to be discussed during the semi-structured interviews. Furthermore, this allowed for a more precise scope to be developed while looking through corporate material to ensure greater efficiency in the data collection phase. The narrative review was focused on the general application of consumer behaviour influences and efficacy in consumer technology, a more detailed or thorough approach could be taken in future studies which instead look at specific tactics being employed by mobile applications.

Issues with accurate data representation have been addressed in this study, there exists problems in gaining accurate insight both from consumers and from products to concisely reflect carbon emissions. Data collection from the company end may be very costly and time consuming for a single market or demographic. Scalability issues may arise when seeking ways to fund such large amounts of data collection so the consumer can have the most accurate and best consumer experience which would hopefully lead to new, more sustainable habits being formed. Access to open source and reliable databases may be a development which requires government intervention to create better scaling opportunities for this consumer technology.

Deeper research into consumers as drivers for change could be conducted and possibly implemented through policy and government to help encourage more sustainable food system practices throughout the value chain. This paper does not strongly consider or research the number of users the carbon or sustainability tracking apps have. A complementary, quantitative research could be done to both verify results and support tactics employed by the mobile applications. It could also lead the way toward a better understanding of many consumers being a driver toward value-chain changes.

7. Conclusions

Consumers are presented with a variety of options when making choices on their food practices. Consumer technology in the form of mobile applications which can track or represent carbon emissions reflected by consumer actions has an opportunity to change consumer behaviour. While an individual often relies on mental heuristics, social norms, and habitual processes to make decisions (Solomon et al., 2016), they are willing to make changes which reflect their values better. Overcoming the values-action gap requires achievable goals and targets which are presented in ways which do not overwhelm a consumer or stray too far away from their current habits. Providing small steps toward a goal have lasting impacts in both changing a consumer's thought process to become more cognitive and encourages impactful sustainable habits in the long-term.

Educating users on the impact of their actions is faced with the challenge of representing data in terms which the consumer can put into perspective. To help motivate and encourage sustainable behaviour change, mobile applications can use gamification techniques such as leaderboards, campaigns and community-based goal setting which provide real-time feedback and allows a user to see how they measure against one another. A sense of community helps to redevelop social and subjective norms, one of the key influences in a consumer planned behaviour decision making process (Ajzen, 1991). App users working together with group goals have a place in leading the consumer to make more cognitive choices toward more sustainable actions.

Consistently checking in and having the ability to see how their food actions impact their carbon score will create a cognitive thought process leading to new mental heuristics and shortcuts where the consumer can make sustainable food decisions more easily.

Sustainable food choices are closely linked to healthier diets which can be a beneficial outcome consumer who also have health related goals alongside sustainability goals. Consumer technology has a place in influencing an individual toward more sustainable food habits developed through helping lead the way toward a more cognitive thought process where the consumer can close their values-action gap.

Utilising gamification, nudging, education and actionable steps carbon or sustainability tracking apps help address issues presented with consumer interaction within a food system. While an individual consumer might be overwhelmed and faced with climate anxiety due to seeing small benefits as an outcome of their actions, creating community and new social norms can significantly help overcome this issue.

Acknowledgements

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Appendix

1.

Leading Questions for companies (Semi-Structured Interviews)

Where are the mains points you might encourage a consumer to behave more sustainably

Find out how many are actively trying to encourage behavioural change vs how many are just a tracking device

According to GIKI (sourced info) about 25% of an individual's carbon footprint comes from food, how much emphasis does your company put on food tracking and suggestions for more sustainable food choices?

In terms of food choices, where can you have the biggest impact on the consumer? i.e encouraging more vegetarian options? Selections at supermarkets? Eating in vs eating out? Local vs import?

Beyond encouragement and tracking with the product, how else does your product engage with the consumer?

Weigh in on responsibility from legislation, companies and consumers – where does the bulk of the burden lay?

How important are food choices for a consumer to lower their carbon footprint?

Importance of economic reform – moving toward more circular economies, how does your product interact with this?

What is the most effective way to educate through your app?

What were the challenges in getting consumers to use the app

What are stats of retention (if they can share)

what changes have they seen and what do they expect in the future

How is it financed – where does the money come from

2. Initial company review.

Company	Details	Key Features	Website
CoGo	Intergration with existing services to track consumer carbon impact and offering real-time sustainablilty data. Created their own ethical nudge framework applying gamification and behavioural science principles to climate action	Gamification, nudging, integrated APIs, live tracking and feedback	https://www.cogo.co/
Giki	A personal guide to understand and reduce a consumers carbon footprint. Offering 6 month steps to help change consumer behaviour toward more sustainable actions. Help to create sustainable communities and workplaces by training embassadors "Chief Greenies"		https://giki.earth/
Adva	Carbon footprint calculator and habit adjustment techniques which utilise gamification elements to encourage sustainable behaviour.		https://www.adva.io/
Klima	Carbon tracking with input from the consumer. Allows for funding of carbon offsetting projects. Offers personalised tips to encourage sustainable behavioural change.		https://klima.com/
Joule Bug	Carbon impact trackers which utilised gamified elements such as leaderboards and trophies to encourage sustainable activities. Has suggested actions for the consumer to take part in sustainable activities	Gamification, suggestions, leaderboard, trophies, education, social	https://joulebug.com/about/
Green Karma	Gamified app that rewards the consumer with cryptocurrencies for completing tasks. Cryptocurrencies can be used to toward real carbon offsetting projects.		https://co2cards.com/
Pawprint	Employee engagement tool aiming to help organisations reach their climate targets. Encourages carbon reducing habits and educates the user on sustainable practices	Education, company integration, team engagement	https://www.pawprint.eco/pawprint-app
Joro	Integrated tracking as you spend - allows connection with credit card. Allows the user to automatically spend to offset carbon with their chosen projects	Education, Integrated tracking with spending, leaderboard/gamification	https://www.joro.app/
Yayzy	Integrated tracking as you spend. Offsetting directly through the app		https://www.yayzy.com/

LiveGreen	Business employee integrations to help a company reach its carbon goals. Offset through chosen carbon projects. Company leaderboards	https://livegreen.io/
Carbn	Focus on habit forming toward more sustainable behaviours. Earn credits for achieving sustainable goals. Leaderboard. Exchange credits low carbon products	https://www.carbn.com/
Decarbon	Intergrated tracking, allows setting of a carbon budget. Direct carbon offsets	https://decarbonapp.com/
Earthly	Automatically offset carbon impact every month. Integrated tracking	https://earthlyapp.com/
eevie	Employee engagement to help organisiation reach sustainability goals. Helps foster climate friendly companies	https://www.eevie.io/
EcoHero	Tracking eco activities, meals, transport, lifestye and plastic usage. Social media elements, ability to share activities, challenges (gamification), rewards, educations	https://ecohero.app/
Ailuna	Sustainability training app, educating the consumer to create more sustainable habits - strong emphsais on sustainable eating	https://www.ailuna.com/
Greenr	Tracking habits and activities, competitive scoreboards, offsetting directly thoruhg the app	https://www.greenr.com/

Your insignificant carbon emission contributions and what to do about it

If you had a way to know your carbon impact based on every action, how do you think you would change your habits? Would you know where to start? What are your regular behaviours that contribute to carbon emissions, and what are your alternatives?

Would any of your individual actions even make a difference?

…There is an app for that.

On your phone, you can download a multitude of apps which are developed to track your carbon emissions based on what your actions and spending habits are. If you have goals to identify and reduce your carbon emissions, then these apps can help you along the way by illustrating the impact of your actions and suggest ways to reduce your impact. Humans being habitual, social creatures have certain intrinsic values and complex subconscious decision-making processes which lead us to behave the way we do. To begin to change this, we must recognize the values which are most important to us when we try to turn unconscious and habitual behaviours into an extended decision-making process, leading to a desired outcome – in this case, reducing one's food carbon emission.

This paper identifies the drivers and influences which lead us to make decisions which align with our value to reduce our carbon impact using consumer technology. It is discovered that small, actionable goals help an individual to change behaviours which will lead them toward more sustainable habits. Further, being social beings, we desire a way to connect with others who have similar values to us – when we join a campaign or group challenge on these apps there is a significant increase to one's motivation and change toward more sustainable actions. Techniques such as gamification, education and nudges are used by companies which have developed apps to help you make more sustainable decisions.

A typical omnivorous diet emits roughly 1.5 tonnes of carbon emissions in a year, less for those who are vegetarian and far less for those who eat from their own land or villages. A puny contribution to the 33,000,000,000 tonnes of global carbon emissions per year. It's not all that grim, what if you and 10 of your friends aimed to drop 0.5 tonnes off your food emissions each. What if you could connect with 50,000 people around the globe that made the same pledge and could check each other's progress? These actions start to seem more significant. Consumers being a driver for change through demand of more sustainable products could perhaps lead companies and governments to consider offering more sustainable alternatives. This mass adoption could lead to long term sustainable system change driven by demand.

Perhaps on your own, there is little significance to your food carbon emissions. But you have intrinsic motivations and values which make you strive to do better anyway. You want to learn how to take steps to make more sustainable choices with your food habits and extend that to other activities in your life. Then you realize there are conceivably millions of others who share values and goals just like you. You begin to think that maybe eating less meat and buying local produce isn't so useless after all.