Food | Consumer | Health
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Position document 'Laboratories and research facilities in the field of food and health consumer behaviour and lifestyle'

Connecting laboratories and facilities

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Summary

The European landscape of facilities for consumer research is diverse and fragmented. In order to better understand what type of consumer research is being generated, in which types of facilities and laboratories and for what purpose, a mapping exercise was undertaken. The mapping was undertaken in several steps, including previous work done in the EuroDISH project, web-based research and consultation of RICHFIELDS members, who are experts in to this research area. Various research laboratories and facilities were identified and mapped both geographically and in terms of their key components. A total of 37 facilities were identified, four of which could be classified as commercial applications (e.g., virtual stores offering services such as assortment testing for existing and novel products) that did not produce research data that could be shared through RICHFIELDS. The remainder of the facilities was either run by academic institutions or industry, with public, private or public-private funding sources. The facilities further differed by the type of stimuli used: real foods vs. virtual foods vs. fake foods. Three main areas of research were identified: (a) food choice (including perception, preference, acceptance, and taste tests), (b) purchase decisions and possible determinants (store design, food labels, novel product launches) and (c) consumption behaviour (preparation, serving portions, left-overs/food waste) and possible determinants (e.g., sensory properties of food, the role of social and physical environments etc.). A geographic mapping was carried out as well but since this exercise has not had the aspiration to be exhaustive but rather to illustrate the diversity of research labs and facilities available in Europe, the distribution across EU Member States is not of core interest here.

Due to the exploratory approach, the mapping is not comprehensive or complete. However, it provides an overview over existing RICHFIELDS stakeholders and can be used to inform Phase 3 of RICHFIELDS. In particular it provides a list of active consumer behaviour research facilities and an overview of tools and technologies. This can serve as a reference for potential stakeholders of a RICHFIELS core offering and provides insight on potential data sources and structures.

Further to the mapping, two potential stakeholders of a RICHFIELDS platform were selected for in-depth interviews: the Nestlé Research Centre and the Paul Bocuse Institute (IPB). These two research facilities were selected because they represent two distinct stakeholder types that generate consumer behaviour data and could potentially be interested in the core offering as well as collaborating on a future RICHFIELDS platform.

Nestlé S.A. is a Swiss transnational food and drink company headquartered in Vevey, Vaud, Switzerland, and the IPB is a hotel management, hospitality and culinary arts school with a Centre for Food and Hospitality Research in Lyon France. These research centres have different funding models, and with that different interests – from industry-funding to public-private funding, and from commercial interests to research advancement. Nestlé is the largest food company in the world with different research centres all over the globe and the IPB is a

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comparably smaller but well-renowned public-private research institute located at a single site that is active in cross-country research projects and scientific publications.

Both institutes were interviewed by RICHFIELDS partners to better understand their structure, how they collect their data, how data are being stored and whether there is interest in participating in RICHFIELDS.

The results of the two interviews show that interest in participating in research infrastructures like RICHFIELDS exists, but it comes with requirements that differ based on the type of research facility. For industry-based research labs within the food company, access to comprehensive data sets is of interest. More collaboration between industry and academia was identified as a need and better access to available, standardised data would be a prerequisite for intake and consumption analyses across different eating/consumption contexts (e.g., in-home vs. out-of-home and across meals, over an entire day or longer periods). For the public-private research institute at IPB, compliance with national laws on data privacy, ownership of data and ethical requirements are important – future RIs such as RICHFIELDS will need to take into account access strategies that ensure compliance with national legislation regarding data sharing, data storage and possible data deletion after a certain period of time. A repository for research protocols was further suggested, to enable researchers (especially young researchers) to map existing research endeavours, e.g. in order to replicate findings in new studies, with different sample populations, to strengthen the body of evidence in a specific field.

The interviews with the two potential RICHFIELDS stakeholders provide insights into their interest and opinion in contributing and benefiting from a RICHFIELDS platform. The findings can be used to inform the core offering and potential business model of RICHFIELDS.

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1 Mapping research laboratories and facilities across Europe

The aim of this study has been to explore existing research laboratories and facilities across Europe, where they are based, what type of research they undertake, how their business models look like and – ultimately, whether they would be interested in participating in the RICHFIELDS RI. The report consists of two chapters – a mapping exercise to better understand which facilities exist and in-depth interviews with two selected facilities to better understand their needs and wants in detail.

1.1 The mapping procedure

As part of WP10, detailed case studies on three selected research laboratories associated with partner universities within the RICHFIELDS project (Fake Food Buffet at ETH Zurich, FoodScape Lab at Aalborg University and the Restaurant of the Future at Wageningen University) have been carried out. These are presented in Table 1. Taking the structure of these laboratories as a point of departure, an overview of descriptors was developed that would be of interest in mapping further research laboratories and facilities.

Based on this, a starting point for the mapping exercise was developed. The remit had to be narrowed down, in order to ensure the feasibility of this task. This included a clear statement of the aim of this activity: to investigate the breadth of existing research laboratories and facilities in Europe that generate consumer data on food and health, mapping the diversity of different facilities rather than offering a comprehensive list of all existing facilities. This mapping should inform RICHFIELDS of the multitude of data around consumers, food and health that is currently being collected, using various technological devices. It was further hoped that the funding models could inform the alternatives available to the RICHFIELDS research infrastructure. A more comprehensive map of existing laboratories and facilities that could share their data will become necessary only when the research infrastructure will be built, in a next step (and project).

The main point of departure for this mapping exercise has been the work carried out in the EU-funded project EuroDISH (Grant Number 311788) and published recently (Brown et al., 2017). The list of facilities mapped in the context of EuroDISH was screened to select those that were appropriate for the needs of this task. This included the research remit of those facilities (consumer, food and health) and available information about the establishment online. Subsequently, an online search was undertaken, using general key words at first [consumer research, consumer laboratory, research laboratory + consumer, food research + laboratory etc.] and more specific terms throughout the duration of the search [university research lab + food, research + food + consumers, food choice + research, food consumption + research etc.]. Once a first list of facilities was established, it was shared with WP10 and phase 2 partners, for input and further recommendations. A number of additional facilities could be identified throughout

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this process. At several events and meetings, the mapping exercise was mentioned to consortium partners, asking for input and suggestions. Early 2017, a complete list was shared via email and made available to all project partners via Basecamp, in order to elicit additional research laboratories and facilities.

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Table 1: Case studies on three research laboratories in RICHFIELDS (WP10, tasks 10.2 and 10.3)

"Food" Tech-nology	Cases	Description of "food tech"	Description of data capture = outcome measure	Strengths	Weaknesses
Real food	FoodScape Lab	A facility with a Cook, Eat & Serve area	Observer XT, Intelligent Buffet, Heat Mapping, eTracking	Familiarity, variety of study settings and designs possible, complete observation possible, larger groups can be studied, real food can be used	Costs, preparation, cleaning
Real food	Restaurant of the Future	Full restaurant on-site of the university, with real foods	Food choice, meal composition, food labelling or packaging effects, portion sizes (scales in the floor), purchase behaviour, price effects	External validity (real-life setting), complete flexibility in designing the studies, automatic data capture through till receipts and scales in the floor	Cost of running a regular restaurant (but shared with university)
Fake food	Fake food buffet	A buffet with replica food items from which subjects choose from	Portion sizes, meal composition, applied knowledge, alignment with dietary guidelines (%GDA, RDA)	Low costs, no cleaning, highly controllable environment, reproducibility and validity, experiments, assessment of meal composition (complex choices) environmental influences, applied knowledge	no consumption, or food odours (yet)
Virtual food	FoodScape Lab	A virtual food environment that can be shaped in any style and in which consumers can shop virtually	Software/hardware based (for instance put on shopping trolley, brought to check out aisle, purchased with "virtual money"	Low cost, easy to set up experiment, no cleaning, easy and fully automatic data capture	Unfamiliarity, unknown validity

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1.2 Overview of research laboratories and facilities across Europe

The mapping identified 37 research infrastructures and facilities. Details on geographic location, affiliation, funding/business model, legal status, research focus and technologies used and type of data collected is presented in Table 2 and 3.

The infrastructures were separated into research laboratories and facilities and those that only serve a commercial purpose, such as selling a software or analysis tool, in combination with additional services such as study design, analysis and reporting.

Figure 1 presents a geographical overview of the mapped facilities.

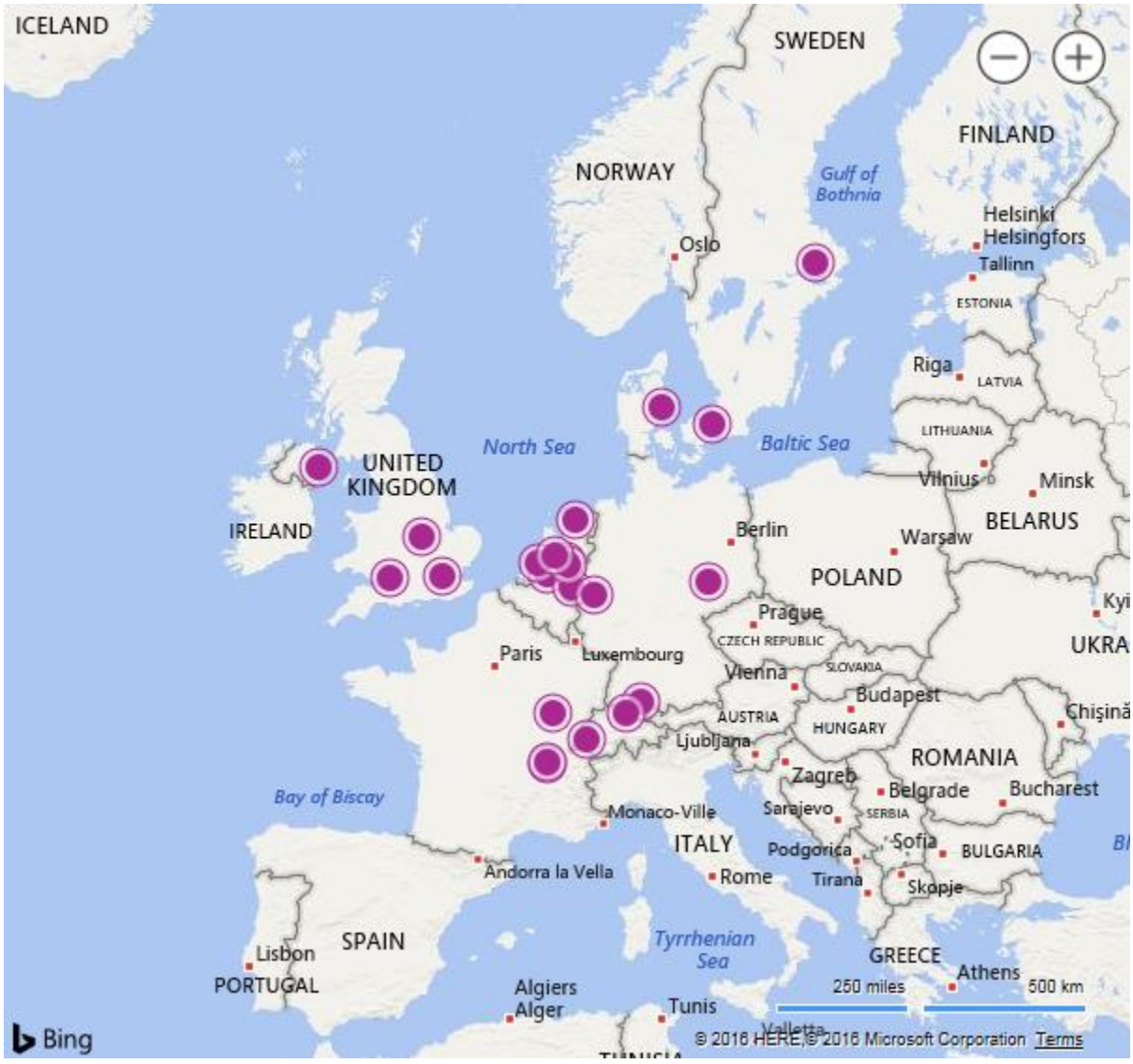

Figure 1: Geographical overview of the mapped research facilities and laboratories in the EU

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Table 2: Overview of research laboratories and facilities in Europe, on consumer research into food and health

Country	City	Name	Organisation	Funding / Business model	Legal status	Stimuli	Short description (what are the research questions this facility can tackle)	Technology	Type of data collected
CH	Zurich	Fake Food Buffet	ETH Zurich	Institutional funding, no business model yet	Academic	Fake foods	A buffet with replica food items from which subjects choose from	Scales, manual input of food choice (tablets), additional survey tools	Portion sizes, meal composition, applied knowledge, alignment with dietary guidelines (%GDA, RDA)
CH	Zurich	Consumer Behaviour Group	Department of Health Sciences and Technology, ETH Zurich	Institutional funding, no business model yet	Academic	Real and virtual foods	Research into consumer behaviour, e.g. food choices and decision-making processes	Eye-tracking, virtual buffet settings	Food choice, portion sizes, meal composition
NIRL	Belfast	Fake Food Buffet	Queens University, Belfast	Institutional funding, no business model yet	Academic	Fake foods	A buffet with replica food items from which subjects choose from	Scales, manual input of food choice (tablets), additional survey tools	Portion sizes, product choice and food labelling (photographs of selections with markers)
DE	Konstanz	Fake Food Buffet	University Konstanz	Institutional funding, no business model yet	Academic	Fake foods	A buffet with replica food items from which subjects choose from	Scales, manual input of food choice (tablets), additional survey tools	Social influences on food choice
DE	Cologne	Fake Food Buffet	University of Cologne	Institutional funding, no business model yet	Academic	Fake foods	A buffet with replica food items from which subjects choose from	Scales, manual input of food choice (tablets), additional survey tools	Social influences on food choice

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DK	Copenhagen	FoodScape Lab	Aalborg University	Institutional and external funding	Academic	Real foods	A facility with a Cook, Eat & Serve area	Observer XT, Intelligent Buffet, Heat Mapping, eTracking	Observation, built-in scales, manual calculation of food choice
DK	Copenhagen	FoodScape Lab	Aalborg University	Institutional and external funding	Academic	Virtual foods	A virtual food environment that can be shaped in any style and in which consumers can shop virtually	Software/hardware based (for instance put on shopping trolley, brought to check out aisle, purchased with "virtual money"	Food choice, meal composition, food labelling or packaging effects, food purchases
NL	Wageningen	Restaurant of the Future	Wageningen University	Institutional funding	Academic	Real foods	Full restaurant on-site of the university, with real foods	Observation, video surveillance, sales data, built-in scales, additional survey tools, automatic client data	Food choice, meal composition, food labelling or packaging effects, portion sizes (scales in the floor), purchase behaviour, price effects
NL	Wageningen	Marketing & Consumer Behaviour Group	Wageningen University	Institutional funding	Academic	Virtual foods	Understanding consumers' buying and consumption processes, and their determinants	Eye-tracking, virtual supermarket, laboratory studies	Food choice and purchase, labelling or packaging effects
NL	Wageningen	Sensory Science and Eating Behaviour Group	Wageningen University	Institutional funding	Academic	Real food	Understanding of the meaning of sensory signals for eating behaviour; includes the effect of the (social and physical) environment on eating behaviour	Olfactometer/gustometery, brain imaging (fMRI), behavioural observation techniques	Food choice, preferences
BE	Limburg	Retail Design and Research Lab	Provinciale Hogeschool Limburg, PHL University College	Commercial	Academic	Real foods	Research on the interior design of stores: influence of the store environment (e.g., lighting or olfactory) on purchasing behaviour, shopping habits and approach-avoidance behaviour	Observations (store with one-way mirror), video games, questionnaires, interviews	Food choice, food labelling or packaging effects, store and isle layout, assortment effects, foor purchase

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UK	Leicester	Retail Lab	De Montfort University, Leicester	Commercial	Academic	Real foods?	Virtual test space for concept evaluations; mock shop retail laboratory Measure the relationships between consumers, products and environments	Store design, consumer behaviour, usability, environmental metrics, marketing and technology leadership	
NL	Vlaardingen	Unilever Research Laboratory	Unilever	Commercial	Industry	Real foods	Global development centre for spreads and dressings brands, and the regional centre for laundry, skincare, hair care and machine dishwash products		
FR	Ecully	The Centre for Food and Hospitality Research (CENS)	Institut Paul Bocuse	Public-private funding	Industry	Real foods	Taste and pleasure of food, nutrition and health (well-being), and the effects of the environment; how people cook food and how they make choices out-of-home Research, teaching students and consulting (public-private funding)	Built-in Living Labs; complete observation possible (cameras, microphones), experimental chamber and platform available to any type of real-life restaurant/canteen/hotel food study Sensory analysis, ethnographics, cognitive ergonomics	Food choice, preparation and consumption
FR	Pierre Benite (Lyon)	European Centre for Nutrition and Health	Rhône-Alpes Research Center for Human Nutrition	Research funding from members (universities) and grants	Public interest organisation	Real foods?	Three main areas cover nutritional physiology, malnutrition and overnutrition Studies on risk self-assessment and self-monitoring (exploiting the face as a major indicator of individual's well-being by tracing traits of physical and expressive status)	Clinical trials (e.g. biological sampling like blood tests to study hunger and satiety), Sensory analysis, multisensory analysis	Eating behaviour: food choice, consumption

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NL	Wageningen	Top Institute Food and Nutrition (TiFN)		Public-private funding	Public-private partnership of industry and academia	Real foods?	Precompetitive research on: Food Chain Sustainability and Dynamics, Microbes and Function, Nutrition and Health, and Sensory and Structure	Phenotyping of individuals and mapping of interacting lifestyle factors in nutritional research; Psychological and biological mechanisms of food properties	Food choice, liking, desire for certain foods, lifestyle factors
DK	Copenhagen	Design and Consumer Behaviour (DCB) section	Department of Food Science, University of Copenhagen	Institutional and external funding	Academic	Real foods	How senses are connected to appetite and food behaviour Research areas include: • Food choice, acceptance and habits • Multisensory food perception • Sensory and situational meal design • Neurophysiology of food behaviour	Multi-sensory analysis	Food choice, preparation and consumption
DK	Copenhagen	Sensory Science Group	Department of Food Science, University of Copenhagen	Institutional funding	Academic	Real food, food pictures	Research areas include: Food preference and acceptance, food perception and sensory identity, and physiology of food behaviour SENSELAB: concepts that influence food choice OBSENSE: facial expressions, food intake and social interactions	Olfactometer laboratory (e.g., a 6-channel olfactometer) Electrophysiology (EEG, electro-dermal reactions, fMRI) Sensory profiling (Focus/training room, consumer tests rooms, sensory kitchen, sensory profiling) Designated labs (sensory/neurophysiology lab, behaviour observation lab, molecular gastronomy kitchen, sensory education lab)	Food choice, food preferences, consumption effects

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DK	Copenhagen	Fair Speak Group	Copenhagen Business School	National research grants	Academic	Food pictures	Analyse the information found on food labels, including consumers' ability to understand it	Eye Tracking, visual semantic tests (using food pictures), attitudinal research	Effects of food labelling
DK	Copenhagen	Nordic Food Lab		Supported by independent foundations, private businesses, and government sources	Non-profit open source self-governed organisation	Real foods	Investigate food diversity and deliciousness, combine scientific and humanistic approaches with culinary techniques	Literature reviews, sensory analysis, new food sources (insects)	
UK	London	MRC Clinical Sciences Centre	Imperial College, London	Institutional funding	Academic	Food pictures	Participants look at pictures of food	Magnetic Resonance (MR) Scanner	
CH	Lausanne	Nestlé Research Centre	Nestlé	Commercial	Industry	Real food		Sensory laboratory, 'Test' shelves, Face/emotion recognition, Eye tracker, Electroencephalography (EEG)	Portion sizes, food choice, preferences
FR	Dijon	Centre for Taste and Feeding Behavior (CSGA)	CNRS, INRA and University of Burgundy	Public-private funding (e.g., research grants)	Academic	Real food	To better understand physico-chemical, molecular, cellular, behavioural and psychological mechanisms underlying sensory perception of food (e.g., psychology and behaviour of consumer, changes in sensory perception and pathological conditions (nutrient excess, aging))	Sensory analysis (e.g., gustatory and olfactory sensitivities), lab facilities (electroencephalography or functional magnetic resonance imaging (fMRI))	
SE	Uppsala	Department of Neuroscience	Uppsala University	Institutional funding	Academic		Behavioural aspects of the central regulation of food intake	Magnetic Resonance (MR) scanner	
NL	Utrecht	Image Science Institute	University Medical Center, Utrecht	Institutional funding	Academic	Food pictures?	Dentistry, Medical Physics, Nuclear Medicine, Radiology, and Radiotherapy	Magnetic Resonance (MR) scanner	

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DK	Aarhus	MAPP Center for Research on Value Creation in the Food Sector for Consumers, Industry and Society	Aarhus University	Institutional and external funding	Academic	Real food, food pictures	Core research area is consumer behaviour with regard to food and drink, embedded in a value chain perspective	Web-based tools	Food choice, preferences, understanding
UK	Bristol	Nutrition Behaviour Unit (NUB)	University of Bristol	Institutional and external funding	Academic	Real food, food pictures	Psychological and biological controls of appetite and food intake	Laboratory, research kitchen, phlebotomoy rooms, web-based tools	Food choice, preference, food intake
DE	Leipzig	Institute for Human, Cognitive and Brain Sciences	Max-Planck Institute	Institutional funding	Academic (association, society)		Neuroanatomical sites of eating behaviour	Magnetic Resonance (MR) scanner	Behavioural measures (attention, gaze etc.)
NL	Nijmegen	Bar Lab	Radboud University	Institutional funding	Academic	Real food	Observational studies on consumer behaviour (drinking) in a social setting	Unobtrusive cameras, recording devices, and a professional beer tap	Food choice and consumption
NL	Utrecht	Self-regulation Laboratory	Department of Health Psychology, Utrecht University	Institutional funding	Academic		Experimental, cross-sectional, and intervention studies on health (particularly food) behaviour in relation to self-control and regulation: resource depletion, planning & proactive coping, self-licensing and confabulation, emotion, temptation an nudging	Self-report, behavioral, and brain imaging methods	
NL	Utrecht	Nutricia Research Utrecht	Danone	Partnerships (e.g. INRA, TiFN), public-private partnerships	Industry	Real food	Sensory and consumer testing laboratory: early life nutrition and advanced medical nutrition		
NL	Drachten	Philips Product Research Centre	Philips	Commercial	Industry	Real food	Sensory and consumer testing facility	Kitchen, Taste labs	Food preparation, consumption

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NL	Breda	mADE	NHTV Breda University of Applied Sciences	Public and private funding	Academic	Virtual foods	A media lab that can put participants in the center of a virtually projected world and facilitates the measurement of responses as choice, eyetracking and bio measures.	Virtual worlds (City, Supermarket, game environment) Mobile eye tracking, heart rate, skin cunductance, muscle tension, blood volume pressure, respiration, reaction times.	Choice, liking, bio measures.
DE	Tönisvorst	real,- Future Store	METRO Group (Future Store Initiative)	Commercial	Industry		The complete purchase process can be tracked and mapped (NPD and product testing, shelf positioning, assortment, in-store design, pricing, promotional activities etc.)	Mobile shopping assistant (smart phone app), self-service scanners, 2 store robots ("Ally" and "Roger"), RFID for smart store logistics and assortment	Sales (food choice, packaging, labelling, pricing, shelf positioning, socio-demographic factors etc.)

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Table 3: Overview of commercial research laboratories and facilities in Europe, on consumer research into food and health

Country	City	Name	Organisation	Funding / Business model	Legal status	Stimuli	Short description (what are the research questions this facility can tackle)	Technology	Type of data collected
Commercial applications									
UK	Milton Keynes	Kantar Retail Virtual Reality Solutions	Kantar Retail	Commercial	Industry	Virtual foods	Customised web-based simulation of virtual stores	Eye-tracking, virtual aisles	Assortment, product launches, package design, decision-making during purchase, product pricing
SE	Stockholm	Simstore	GfK Norm	Commercial	Industry	Virtual foods	Customised virtual store to research food purchase behaviour	Web-based simulation of virtual stores: optimal shelf lay-out, assortment, product launches, package design, decision-making during purchase, product pricing	Food choice, food labelling or packaging effects, store and isle layout, assortment effects, foor purchase
FR	Bordeaux	ACTISU	ACTIPLAY Holding Group	Commercial (Partners with market research agencies to offer research packages)	Industry	Virtual foods	Customised virtual store to research food purchase behaviour	Software for a 3-D virtual store	Food choice, food labelling or packaging effects, store and isle layout, assortment effects, foor purchase
ES	Barcelona	Shopper FACT	SHOPPERFACT Inc.	Commercial	Industry	Virtual foods	Customised web-based simulation of virtual stores	Virtual reality software and client analysis services	Assortment, product launches, package design, decision-making during purchase, product pricing

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2 In-depth interviews with selected research laboratories and facilities

Building on the mapping exercise, two research facilities were selected for a more detailed investigation, by means of in-depth interviews. These were the Nestlé Research Centre in Lausanne, Switzerland, and the Paul Bocuse Institut in Lyon, France. The two facilities were selected as an extension to the three case studies undertaken in tasks 10.2 and 10.3 of this work package. The Nestlé Research Centre represented an industry-run facility with commercial interests while the Paul Bocuse Institut represented a public-private funded institute with interests in research that could be published.

The objective of these interviews has been to deepen RICHFIELDS' understanding of what constitutes best practices for organisations to collect data on consumers, food and health. More specifically, the interviews were carried out with a focus on which IC technologies are used to capture these data, how they are structured, and how they are stored. These aspects were discussed in order to assess whether such data would be of value to the research community and in case of data sharing, what potential privacy issues, IPR, and ethical constraints would be. Additional topics included research interests and needs of the two facilities, gaps they identified where RICHFIELDS could offer value and what they thought of the overall RICHFIELDS approach.

The interview guide was adapted from the joint phase 2 protocol, as the objective had been to ensure a similar structure of interviews carried out across WPs 8 and 10. The questions were adjusted to the needs of WP10 and the specificities of the interview partners in this task. The complete interview guide can be found in the appendix. Both facilities agreed to meet with RICHFIELDS partners in March 2017 (month 18) and were provided with the interview guide in advance (see appendix 1), in order to prepare for the discussion on site. RICHFIELDS partners also received a tour of the Paul Bocuse Institut to better understand what the facility offered.

The following section will provide a summary of the insights from both interviews. It will not closely follow the interview guide as some questions offered less discussion than others and due to the richness of the data, an output-oriented reporting style was seen as beneficial.

2.1 Institut Paul Bocuse, Lyon (FR)

As a research centre adjacent to the famous school for culinary practices and hospitality management, their scope is oriented towards innovation in the area of food preparation and consumption. Facilities include an experimental restaurant and kitchen, several laboratories for food preparation, a number of service locations from bars to cafes and restaurants that can be

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subject to studies and various areas for workshops, e.g. for wine and spirits tastings. The Institut Paul Bocuse (IPB) is open to new approaches as well as new partnerships in order to build connections to conduct scientific collaborative research projects on meals, improve user experience, develop new products and design new services. Depending on the aim and the scope of each study, users are experts or consumers in a specific field. Various goods and services are studied by users in in-situ settings at the stage of early prototypes as well as in the course of the development of common usage. Besides data gathering, researchers translate behavioural observation and measurements into meaningful insights and/or scientific data in collaboration with actors from academia and industry.

For scientific research, the activities lead to publication in international journals, whereas consulting studies usually lead to private results for the sole ownership of the client. In-between those two opposite cases, works conducted within the research and innovation committee – a gathering of industrial partners – lead to shared and published results at the methodological level while some results may be kept confidential.

Concerning ethical governance, subjects do not know the exact purpose of the study; for example they could be eating at the regular restaurant where prices or new items on the menu are tested or experimental conditions are on-going for a given research questions.

The funding/business model for IBP is Public-Private (academic research that will be published vs. commissioned studies incl. consulting services where results remain confidential, if necessary).

Attendees of the interview were the Director of the Research Centre (Dr Agnès Giboreau) at Paul Bocuse as well as managing research staff (Dr Laure Saulais and Dr Anestis Dougkas).

For what purpose does your organization collect consumer behaviour data?
IPB wants to play a role in the international research community on consumer behaviour in real meal conditions.

How is data captured?
There are multiple devices at IPB to capture data, including microphones, cameras, consumer devices (smartphones, tablets etc.), and photos/video surveillance. The Noldus system, a software programme for semiautomatic analysis of video data, is used for coding video data.

The experimental restaurant is equipped with cameras and microphones. The entire environment can be controlled; e.g. through temperature, light, and setting (e.g., buffet, canteen style, fine dining).

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Where is the data collected?
There a several locations where data is collected. The most notable ones are the experimental restaurant and actual laboratories where food is prepared.

Which data is collected?
IPB collects two main types of data: behavioural and stated preferences (self-reported). Self-reported data can be collected through online surveys, paper pencil and via direct input into tablets. Surveys are mostly used in nutrition, sensory analysis and psychology. These data include hedonic ratings, preferences, acceptability, feelings, emotions, and hunger. Additional options include closed questions on sensory properties (sweetness, saltiness etc.) and descriptive open ended questions to describe products and liking thereof. An example would be to describe a sandwich: "What are the 3 positive and the 3 negative things about this sandwich?" Behavioural data, i.e. measured data, include consumption, portion sizes, and recording choices.

Qualitative data is mainly collected through interviews and focus groups. Observational data is also being collected, e.g. through video surveillance and food weights (to estimate portion sizes and food intake). Physiological data includes the weight of people but also blood samples, as IPB has a registered agreement with CENS to collect the blood. In some cases, Institut Paul Bocuse can link physiological data with behavioural and perception data but these studies are very expensive.

Sometimes, data are collected in different countries and languages. IPB has some form of standardisation for this but while there are not always validated scales/survey designs in consumer research, there are a number of standardised scales in psychology to use.

As an example of an application, IPB studies food choices in a standardised buffet. Such settings can help answer questions such as "Does fractioning the food eating in the morning influence how much people eat at lunch?"

More recently, IPB has developed an app about eating and culinary practices FLOW, Food and Lifestyle Observatory Worldwide. Upon installation of the app, IPB provides participants with a code to enter the specific study, as there can be several studies running on the app. In one example, participants were asked to photograph their food and then answered a number of questions on the context (e.g., who are you eating with, where are you, where do you buy your food etc.) The app functions like a food diary but in more real-time and with the possibility of sending reminders etc. IPB developed this app without any sponsorship but aims to use it for consulting purposes as well as research ones.

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Data structure

Data is collected in multiple contexts and countries (e.g. surveys). IPB hosts the data at their location and in their partner laboratory.

Types of programs used include Noldus, analytic software (R, SPSS, SAS), Nutrilog for nutrient analysis and Invivo and Alceste for qualitative data (e.g., interviews). Data are typically stored in Excel. As everyone at IPB has a different discipline/background, the researchers prefer different methods and software programmes to analyse the data.

IPB doesn't have a standardised procedure to store data. One of the main reasons is that different projects use different types of methods and collect different types of data.

Privacy issues and data ownership

For the experimental restaurant, for example, customers sign a consent form to allow the collection of their data.

Institut Paul Bocuse complies with the requirements of the French consumer protection agency (CNIL) and for biomedical research, with the Ethical Committee CPP.

Who owns the data?

If IPB collaborates with industry, they often co-own the data which is governed in contracts. Depending on contracts, the raw data can be the deliverable and as such needs to be made available (publicly) but most of the time the analysed data or the report is the deliverable.

When it comes to data from consumers, most of their data is anonymised from the root.

IPB concludes that they have to be careful with sharing data, because their current consent forms guarantee the individuals that the data is not used for purposes other than research.

Would the Paul Bocuse Institute share data with an infrastructure like Richfields?

In principle, there is a clear interest in the RICHFIELDS project. But there are a number of uncertainties revolving around data ownership, privacy and ethical governance that currently hinder IPB from doing so. CNIL, CPP and the general reputation that IPB upholds as a credible and responsible research institute prevent data sharing at this point. Changes in the legal requirements of data handling would be required to enable ways to provide access to data, e.g. temporary access or restricted access or even local access.

Which information needs are not captured? (Which data would be of interest?)

IPB defines the replicability of studies as a need. Replicable data mean the strengthening of knowledge across samples and time points. Populations can differ largely and in order for theories about food consumption to become viable, they need to be tested over and over again.

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This is not sufficiently done in consumer research. Hence, IPB asks for a repository of study protocols. This essential means to map research activities. It would not only help researchers, especially young researchers, to know what has been worked on but also what worked and what didn't. Learn from others' mistakes, so to speak. Or, find ways to improve those study designs so they no longer fail. In the future, this could lead to a registration process for all study protocols, similar to registering systematic reviews. This could help standardise research endeavours and avoid parallel efforts.

Standardisation is also important (e.g. variable naming, further harmonisation) as it could help make results more comparable across research disciplines. In line with the above, a standardised way of describing study designs, data sets and even variables (as part of the protocol repository) could help researchers understand what problems others encounter and ideally lead to the generation of stronger hypotheses in the future. IPB suggests a position paper on what constitutes good data, including ideas for standardisation and harmonisation, ways to generalise and transfer data as well as how to map the type of data that is collected overall.

For IPB, inter-individual differences are needed. Individual level data such as how people eat, what their sources of energy are in a meal but also over the entire day. Big data could be a way to deal with this. At the group level, you often don't see any differences anymore. If the RICHFIELDS RI could offer access to such data, it would generate large interest. This could include learning how to use big data. In this context, IPB suggests a 'task force' within RICHFIELDS to investigate inter-individual differences and identify patterns from big data.

Thoughts and general comments about RICHFIELDS

The initial reaction from IPB is that they are not comfortable with sharing all of their data, without more specific rules in place. They are aware of their unique place within the research community and they want to be an active partner, by contributing their knowledge on how to conduct research. In order to drive such a research infrastructure, IPB would be interested in attending future RICHFIELDS workshops and being involved in the next step, the building of the infrastructure. From their viewpoint, only a combination of expertise and experience of all partners can help achieve better protocols, hypotheses and more valuable research in the future.

2.2 Nestlé Research Centre, Lausanne (CH)

Attendees from Nestlé Research included the Group leader as well as an expert scientist of the dietary intake group (Institute of Nutritional Science), the Head of the Department for Consumer Science and Applied Nutrition (Institute of Material Science), Consumer Centricity in R&D Head, and data scientists involved in clinical trials.

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What purpose does your organisation collect consumer behaviour data for?
Different units in nestle research have different needs and collect research data at different levels. Nestlé collects research data at any point of the value chain. Basic research data is collected to assess dietary and health benefits of products (e.g., evidence for health claims) and at population level. Behavioural data is gathered to gain scientific insights into how consumers select and purchase food products. At the end of the product chain, data is collected on liking and preference to inform product development. Examples include data that helps understanding the drivers of choice. This data is collected to understand consumers eating behaviours and habits to support product optimisation and the promotion of healthier eating behaviours.

In the future, Nestlé would be interested in collecting individualised data and linking it with other data to provide consumers with personalised feedback.

Where is the data collected?
There are two main centres linked to fundamental science on nutrition and health: the Nestlé Research Centre (NRC) in Lausanne and the Nestle Institute of Health Science, on the campus of the École polytechnique fédérale (EPFL). The latter provides and translates biomedical research into personalised science-based nutrition while the former provides the scientific knowledge and research base for product renovation and innovation.

Consequently, at the NRC, the focus lies on applications and solutions. The research is more focused on guidance to make products healthier and product development with commercial aspects and consumer preferences in mind. Eating behaviors/product preference/sensory characterization and all those data are connected to drive healthier product adoption and healthier product development.
Additional facilities include, for example, the NRC hub in Singapore where research on ageing populations is undertaken and the NRC hub in St Louis where Nestlé conducts research on pets and pet owners.

Which data is collected?
A variety of data are being collected for the needs of a global player in the food and health sector. Examples include sales (global, local), preference data, sensory data, personal data (de-identified), data on portion size, facial recognition (infants), infant feeding studies, clinical trials (body composition data), process data, product validation (measures for product success), eating contexts, reasons for consumption, heart rate, movement, muscle activity (chewing) and many more.

"We use complex mathematical models to connect different sources of data and get new insights on understand consumer needs/drivers of choice and sensory properties giving important guidance in making

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products healthier and tastier. For example: a consumption driver is sweetness, but we also need to reduce sugar (consumer need). Therefore, we work on flavour improvement in combination with sugar reduction.

Furthermore, Nestlé observes a trend towards more in-home research as compared to pure lab-based studies. This includes data collection in real-life settings such as in the household.

"There was an evolution from research in lab facilities to more and more research in consumer home environments. The context of consumption is influencing behaviour and that is why we move to do research within these more complex environments."

Main challenge is how to connect data from various sources. Due to the magnitude and variety of the data collected globally, Nestlé reported essentially facing the same challenges with regards to available research data as RICHFIELDS: the challenge is how to connect all data in order to get a more comprehensive picture of consumer behaviour.

"There are about 30 technology centres around the globe. They all do consumer tests. We around the table have no idea about the full picture of the data. We are a little world and have the same problems as RICHFIELDS".

The size of the company and the diversity of the work conducted together with having a local (decentralised) strategy make it very complicated to centralize data, however, initiatives are in place to favour connections and centralization of data. Currently there is no central repository that could provide an overview of all available data within the company.

"Historically, Nestle was a decentralised company. We are currently working on gathering all systems in one and on centralising. Processes have changed in the last year."

A conclusion was that *"It may not be possible to harmonise all the data, but it is important to have a starting point where we standardise data collection and make data integration easier."*

Closely related to this topic, harmonisation and standardisation were mentioned as important topics for Nestlé. Specific research disciplines were mentioned as examples of existing standardisation which was seen as the way forward for the remaining fields of data collection.

"For clinical trials, we have standardisation projects. Alignment is more and more important. We run 25-30 clinical trials on health benefit for consumers. We work with de-identified dietary data that we receive from research partners. This is individual level data that is de-identified."

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How is the data captured?

Various data are captured in different ways. This includes data collected from consumers on sensory dimensions such as eating behaviours, product preferences or sensory characterization, and all those data are connected to drive healthier product adoption. Some work has been done on picky eating as well. Data collected on a project basis varies from health parameters, nutrition/dietary intakes, physical activity, and consumption habits to sensory and liking. In a pre-product development stage, Nestlé also carries out 'classical sensory' evaluations. They obtain data from trained external panels, sensory studies, video observation at NRC and even data from other regions such as the US. Part of this data collection process is outsourced. Data is being collected on how people eat, for example consumers are provided with cameras. Data is captured the classical way through interviews, questionnaires and with new modern technology like video and electronic devices. For example, Nestlé has various R&D consumer spaces around the world, including consumer kitchens where participants can be videotaped.

They also use devices for heart rate measurement and muscle activity measurement (chewing). In clinical trials, body composition data on various health parameters are collected.

Data is further collected via consumer devices (apps on phones/tablets). These are used for capturing data in context, e.g. location and activity data. The aim is to integrate the different data and to provide the consumer with individualised feedback on consumption and health behaviour. This becomes possible when consumers generate their own data through apps where they can record the context in which they eat and any reasons for consumption, at the time of the consumption.

What does the data structure look like?

There is not one single answer to this question due to the different sources of data and methodologies applied. As an example, Nestlé works with external databases, i.e. national food intake data. Together with external research partners, they evaluate what people eat and how much and gaps in the diet. This data can be extended with consumer data to enrich the interpretation. A central topic is how to capture intake data and link it to personalized recommendations. Linking nutrient data to intake is also of interest.

For consumer preference data, Nestlé standards are most advanced. All data are harmonised across countries and brands. All the data are linked to one IT application.

"Nestle has a 'home made IT system' that is compatible with SAP. We also use Microsoft cloud. ODM format is used in clinical research as FDA requires this standard."
"We can connect to these data sets via Web services."
"For data analysis we mainly use SAS and R".

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Overall, however, statistical software is not standardised as different researchers prefer different programmes.

"Everyone uses what he or she is familiar with, but the requirement is that all programmes have to be compatible with one system."

Would Nestlé share data with an infrastructure like RICHFIELDS?
On a case-by-case level, Nestle shares data with external partners. There are examples where this has already been done for dietary data. For example, Nestlé participates in a project from the Tufts University – the 'Global Dietary Database' (GDD) which gathers aggregated dietary intake data. In the past, Nestlé provided data from infant feeding studies. The unique identifier of the GDD is that they accept only data that correspond to their standardisation protocols.

"If you can provide the data in the format they want you can provide it. They give you a template, how the data needs to look like; micro-, macronutrients, food groups etc."

Why is Nestle willing to share data, what is the business model?
Nestlé reported that while, as a member of the consortium, they could have posed research questions that would be answered by the GDD, they had not yet done so. The data they shared had been collected in 2008 and results had already been published. They were in the process of collecting new data and had no more use for this older data set. Nevertheless, sharing the data with the GDD was greatly appreciated.

We had gotten out of the data what we wanted. For them it was a big win. It gave us an avenue for further research."

But ultimately, Nestlé agreed that there are more reasons for considering participation in research infrastructures like RICHFIELDS. They recognise the pressure the food industry is under and that only joint efforts will suffice in making a difference, in impacting public health and in offering better products.

"We don't only want to be a food company – we want to be a nutrition and health company. To make products better we all need to work together."

While Nestlé is clearly interested in collaborating and sharing data, those aspects that are important and essential for the market advantage of a product will always be proprietary.

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Privacy issues and data ownership

The data is used internally, but it is also published. Generally accepted good practices are applied to obtain consent from participants in the research. All details are always defined in the consent forms signed by all participants.

Generally, Nestlé does not work with identifiable data, meaning there is no personal identity attached to the data points collected.

Nestlé has ownership of their data and when they work with external agencies or other partners, they ensure complete ownership of the data. All sharing is temporary, covered through confidentiality clauses and has to be agreed on.

The new privacy law is expected to have a major influence on these processes. Contracts will have to be amended and new ways of working will have to be established.

Which information needs are not captured?

For Nestlé it is clear that real-life data are needed. Data on what consumers are doing in different contexts, e.g. home environment vs. out-of-home situations. Data are needed on more than a single product. Future research will consider a complete diet and how dietary behaviour is being impacted. What else do consumers eat, are there interrelations or even trade-offs regarding nutrients (e.g., from breakfast to lunch or from one product to another)? This is closely linked to the issue of portion sizes: which portions of which product are consumed when? What are the 'real' portions that are being consumed? This is especially valuable for snack food where a number of different (recommended) portion sizes are available in the market but it is not clear what the typically consumed portion size of a given snack bar is. This information cannot be calculated from national intake data. Partly, because portions are typically defined as the 'amount of food eaten in one eating occasion' but there is no consensus on what constitutes an eating occasion, let alone a clear view of this terminology in the consumers' mind.

Nestlé is interested in data on portions that are being consumed in reality. Oftentimes, only partial data are collected – for example, in-home consumption but not out-of-home, or canteen food choices but not quick service restaurants or street vendors during lunch break. Relying on self-reported data does no longer suffice as actual intake data often varies quite a bit. And furthermore, much data collection does not include the context in which the food is selected and consumed. However, contextual factors such as home vs. office vs. out-of-home dining, time of day, peer group influence, environmental cues etc. can have a strong effect on consumption behaviour and therefore must be studied in a holistic approach.

"Contexts are very important. Most of the time people consume food at home and that is difficult to get."

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General comments about RICHFIELDS

The main barrier that Nestlé mentions is that industry does often not have direct access to data. This is especially relevant for dietary intake and preference data. If a RICHFIELDS RI could provide access to such data, across several countries, for all stakeholders, this would results in strong interest in. Food businesses alone are not capable of solving the global disease burden by themselves – they need access to all available data in order to analyse consumer behaviour holistically and develop appropriate reformulation strategies. As such, Nestlé calls for a closer collaboration among industry, academia and policy makers. There are plenty other examples of data platforms where companies need an academic partner in order to access and use data. This is perceived as a barrier.

"Researchers from industry and academia are not treated equally. Access is key. Industry needs access to data to make actual improvements. For better global health we need to have a revolution in the relationship between companies, academia and policy makers."

Generally, Nestlé is happy to share data that they do not use anymore. But they say that *"one problem is that sometimes data is very specific and there is no further use of it"*, for example dietary data. Nestlé estimates that there is a lot of data available within the company that would be useful for a research platform. They also support publications of any sort, for example they make their publications open access to widen the outreach of their work. However, they also clearly state that they have projects that are dedicated to be published while other projects have the aim of generating a competitive advantage. In those cases, data will not be shared. For such instances, Nestlé has systems in place that help them assess the risk of losing a competitive advantage when such data are shared.

3 Conclusions and Recommendations

Based on the mapping exercise carried out in the first part of this study, a number of different research laboratories and facilities could be identified. The mapping mostly identified laboratories and facilities in Central and Northern Europe. Due to the explorative methodology, the mapping was not comprehensive and it is important that a future RICHFIELDS infrastructure uses a systematic approach to identify potential stakeholders and also focuses on facilities and laboratories in Southern and Eastern Europe.

It could be demonstrated that a broad range of technologies and methods to capture consumer behaviour data are used. Examples include scales, surveys, computer programs, virtual reality technology, eye tracking and experimental restaurants and blood samples.

The broad variety of technologies and methods involved indicates that a RICHFIELDS data platform must be capable of dealing with a variety of datasets and complexity.

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Notably, the identified facilities differed in their funding model, which is presumably linked to the objectives associated with the data collection. As such, two diverse examples were selected for more in-depth interviews: the Nestlé Research Centre and the Paul Bocuse Institut.

The main finding from interviewing NRC was that for them, the main barrier is direct access to more complete and holistic data (often they need an academic partner to access such data). The food industry is happy to share data that they do not use anymore and they are further interested in participating in cross-disciplinary research endeavours as they recognise that there is considerable pressure to make products and diets healthier – a task that cannot be achieved by one player in the market alone.

The main finding from interviewing IPB has been that for them as public-private research institute, replicable data and standardisation are important. Furthermore, individual level data are needed, e.g. how people eat over the course of a day, both in and out, in different contexts, across different meals. IPB calls for a task force to investigate such inter-individual differences. But they also recognise that sharing data is difficult in the current legal environment as national institutions such as the French CNIL, CPP and other ethical committees require data handling that is not aligned with the idea of a sharing research infrastructure.

Combining these ideas, a protocol standard may be a step towards more inclusive research: if there was a standardised way of setting up study protocols, industry research would be less prone to criticism as long as they adhere to the standards. At the same time, such a protocol standard would need a centralised repository of some sort, to upload and share all study protocols – which would in turn make it possible for researchers to know what type of research is being undertaken by whom.

These findings do have a caveat in the sense that only two facilities were interviewed and their views may not be representative of all existing (or even just the mapped ones) facilities that generate consumer data on food and health. As such, avenues for further research include more interviews with additional facilities, using a structure similar to the guideline in the appendix. This could be amended with workshops where joint positions could be worked on and joint statements could be developed – as a call for action. Nevertheless, the insights provided above are a solid starting point for understanding the needs and wants of research laboratories and facilities in terms of designing a research infrastructure.

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Appendix

Appendix 1 – RICHFIELDS interview guide

Purpose of this interview

We are conducting this interview as part of the RICHFIELDS project. We want to understand what research institutes and laboratories dealing with consumer behaviour (food choice, purchase, preparation and consumption) exist, what their structures are and how they collect their data, e.g. through technologies and devices.

The goal of RICHFIELDS is to design a research infrastructure into which such data can be fed, to increase access to a wider range of available consumer research and behaviour data. We are particularly interested in your views on how such data might be used in future research infrastructures and what the benefits and risks could be in sharing or accessing these data.

The purpose of this interview is to seek your views on

1) what constitutes best practices for businesses to collect food choice data,
2) how to use these data,
3) how these data are structured,
4) how IC technologies can be used to capture food purchasing/procurement data,
5) if such data can be of value to the research community, and
6) in that case what the privacy issues, IPR, and/or ethical constraints would be

Interview questions

Section A: Best practices of collecting consumer behaviour data

1. For what purpose does your organization collect consumer behaviour data?
    a. Who uses your data? (*E.g., internal vs. external stakeholders)*
2. How would you characterise the data you collect
   E.g. is it at aggregate level; personally identifiable (personal health; personal opinions; biological markers); personal but non-identifiable etc.
3. How do you structure your data?
   E.g., a company might collect survey data online with the programme Qualtrics and store the raw data files on local servers in .xml format. The raw data files can be accessed by authorised personnel only, via a shared drive or a password.
    a. Could you explain why the data is structured in this format?
4. Which of your information needs are not captured in your current way of data collection?
    a. Regarding data on consumer behaviour, what do you think is currently missing? What do we need to better understand about consumers, food and health?

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   b. How do you think this challenge can be addressed?
5. What privacy policies do you have in place, when you collect data on consumer behaviour?
   a. What would be the legal restrictions if you were to share your data for research purposes?
   b. In what format should the data captured be shared with others e.g. Richfields platform? What does this depend on?

Section B: IC technologies used to capture data

1. What key IC technology does your organization use to capture and extract information on consumer behaviour data?
   a. Could you give a brief account of the software/hardware dimensions of the technology?
   b. What are the benefits of using this technology?
2. What criteria are used to select the IC technology currently in use?
3. How do you evaluate the effectiveness of your IC technology used for data collection?
4. What role do social media play in your gathering of consumer behaviour data?
5. What do you consider to be the significant challenge(s) of using the kind of data capturing technology available to you?
6. How do you think the use of IC technology can be developed further in the future to overcome the challenges?

Section C: The relevance of RICHFIELDS

1. Do you already collaborate with existing research infrastructures (RI) or other commercial organisations to collect, gather and share your data?
2. What data would you be willing to share with an RI? What not?
3. A scientific case for RICHFIELDS
   a. How would a potential RICHFIELDS platform help address your specific research needs (e.g. questions it will help answer)?
   b. What do you see as the benefits of sharing your data with the research community, e.g. via the RICHFIELDS platform?
   c. What do you see as the risks of sharing your data? Is there a circumstance under which you would not be willing to share the data you collect with the RICHFIELDS platform?
   d. Which potential users of RICHFIELDS would you be willing to share this data with?
      E.g., other researchers or RIs, industry, policy makers, end consumers
   e. What general/long-term impact would/could such a platform have on you?

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f. How should such a platform be designed, in your opinion, to create benefits for those actors sharing their data?

g. How do you think such a platform (data sharing) should be communicated, both to manufacturers and researchers?

4. User group strategy and business model
    a. Would you want to be a potential future user of the RICHFIELDS platform?
    b. What kind of a relationship would you expect with such a platform? (e.g., from a minimum model only providing data to a maximum model with different access rights to the data)
5. Governance and ethics
    a. Do you foresee legal (e.g. competition, access) or ethical (e.g. data sharing, consent) issues in sharing your data with RICHFIELDS?

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