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Innovations in census technology**The use of electronic data collection in the 2021 Census for
England and Wales****Note by Office for National Statistics, United Kingdom of Great Britain
and Northern Ireland¹***Summary*

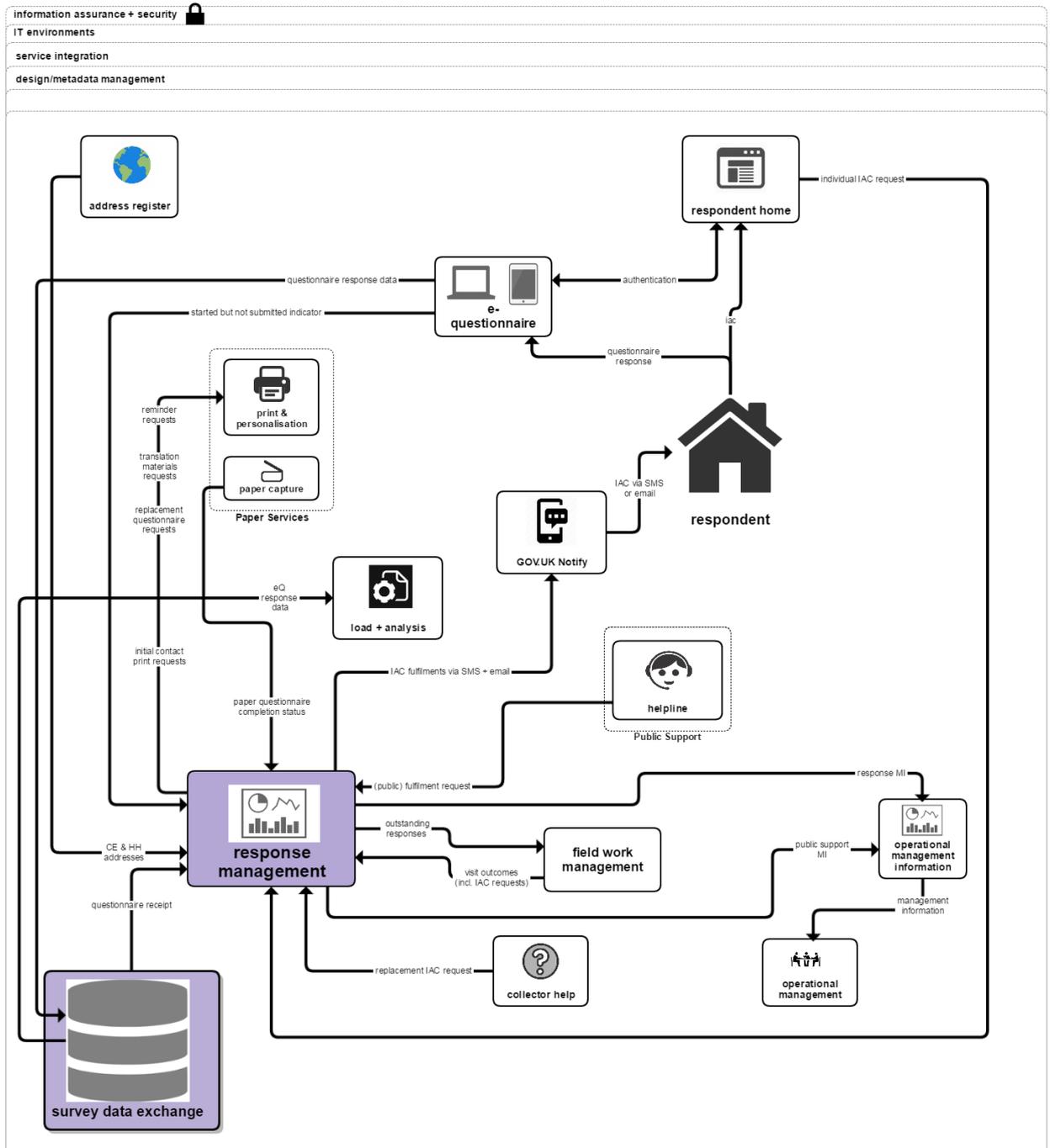
In the 2011 Census ONS used electronic census data collection for the first time. In 2021 we are looking at using a corporate electronic questionnaire and an electronic management tool for fieldwork follow-up activities in order to improve the way we collect our data and manage our operations. Early versions of these tools were used in a 2017 large-scale test, integrated with an electronic response management and tracking system. This paper describes what lessons we learned from this experience, focusing on the fieldwork management tool, and our plans for taking this innovation further.

¹ Prepared by Cal Ghee, Head of 2021 Census Processing

I. Introduction

1. In the 2011 Census the Office for National Statistics (ONS) used electronic census data collection for the first time, combined with a tracking system that received information when electronic forms were submitted, and paper questionnaires were receipted. For 2021 we are developing a system using a corporate electronic questionnaire and an electronic management tool for fieldwork follow-up activities, both integrated into a system for monitoring responses, in order to improve the way we collect our data and manage our operations.
2. In spring 2017, we conducted a large-scale test in preparation for the 2021 England and Wales Census. Part of this test was the use of a Response Management (RM) system, integrated with the corporate online electronic data collection (eQ) and a Fieldwork Management Tool (FWMT).
3. An initial version of the response management product was developed by ONS developers to support the 2016 small scale census test. This provided the foundation for the response management product, which developed into a more sophisticated system for the 2017 Test, enabling 'real time' actions feeding in from electronic questionnaire submissions and receipt of paper questionnaires, helpline calls and field work outcomes. The system was run at headquarters, and was the central information point for management information.
4. We first used the fieldwork management tool in the 2016 Test alongside RM, and modified some aspects for use in 2017. The tool was provided to Census Officers for use on their own devices, downloading workloads in the morning and uploading outcomes every evening, before and after their shift. Data received back provided 'real time' information on visit outcomes which previously would have taken a number of days to process through from the field.
5. The electronic questionnaire used in the 2017 was developed as a corporate tool for use across ONS. This was not used in the 2016 Test, and in 2017 was the first time eQ and RM had been integrated. Paper questionnaire receipting, capturing and coding was treated in tactical way for the test, processed at our Newport office and receipting added in to RM daily on receipt of each batch.
6. The primary objective of the integration of these systems was to make more efficient and effective use of resources by being as up to date as possible. This will help us monitor and maintain response rates across all areas. This paper concentrates on the interaction between Response Management and the Fieldwork Management Tool, as this was the first time we have been able to monitor field activities at this level.:

Figure 1
Electronic Data Collection Products Supporting the 2017 Census Test



II. How the tools worked

2.1. Response Management activities

7. The RM system developed for 2017 is essentially a series of action plans, fed by a variety of inputs including sample addresses, helpline calls, information on submitted online responses and receipted paper ones, and information from field visits. Outputs included addresses for follow-up and management information (see Figure 1).

8. The scope of the response management product was to:

- Hold and manage the address frame (household and communal establishment addresses);
- Create cases for each expected response, with associated unique access codes and questionnaire identifiers applied;
- Apply a schedule of follow-up activity to each case (action plans);
- Distribute print instructions for initial contact and reminder materials, and also for printed materials requested by respondents;
- Distribute non responding cases to the electronic field work management tool for field follow-up;
- Update case histories with calls handled by Public Support;
- Close any outstanding actions for a case when a paper or digital questionnaire response was received;
- Update action plans when unique access codes or paper questionnaires were requested;
- Distribute requests for new or replacement unique access codes to the text message service for distribution to respondents; and
- Provide daily Management Information on operational activities.

9. Table 1 shows the frequency of some of the actions used in the test.

Table 1

Frequency of actions used in Response Management in 2017 Test

<i>Responses, questionnaires</i>	<i>Count</i>	<i>Queries, complaints</i>	<i>Count</i>
Field visit case created	223,787		
Online Code (UAC) Authenticated	78,413	Refusal (incl paper not in that sample)	3,491
Online Questionnaire Response	61,356	General Enquiry	1,361
Paper Questionnaire Response	19,903	Misc (includes telephone capture)	799
Replacement UAC Requested	5,258	Accessibility Materials	272
Household Paper Requested	5,096	Technical Query	250
Undeliverable as addressed	1,679	General Enquiry - Escalated	188
Individual Response Requested	1,638	Field Complaint - Escalated	106
Address Details Incorrect	84	General Complaint	91
Classification Incorrect	22	Escalated Refusal	48
Individual Replacement UAC	13	General Complaint - Escalated	20

2.2. Fieldwork management tool

10. The FWMT resource scheduler was provided with addresses for field visits from RM, and the tool allocated these to field officers according to specified parameters such as officers' scheduled work patterns and geographically allocated work areas. The tool received the addresses from RM and scheduled visits for each worker according to their scheduled work patterns and areas they covered. The scheduler provided 'optimal' routing information for the officers to follow. The tool was downloaded onto Census Officers' own devices, which they used while out in the field to see jobs on their daily list and enter information after each visit. What they saw on their devices was a list of addresses to visit.

11. For the voluntary test, and to minimise the wastage of field visits certain field outcomes fed back to RM and stopped any further actions happening for that address. These outcomes were:

- Invalid - non-private household, or non-residential;
- Invalid - demolished, derelict or under construction;
- No contact - no access, or address not found by field officer.

12. Note, however, that this was a tactical situation for the voluntary test. In 2021 we will be looking at having independent sources to validate field outcomes before we remove them from further action.

13. The tool optimized and scheduled visits for each officer overnight, and the day's workloads were sent to each officer's device after 8am each day. Officers would then use their device during the day, and the only messages during the day were ones that removed visits because a response had been received or a refusal received via the helpline². This was a tactical solution, did work in the majority of cases, and was a vast improvement on not having this intelligence in previous field operations. It should be noted that if the officer was offline, these messages would not be received. This and other minor issues that we encountered are aiding our understanding of specifications for our future tool.

14. However, the tactical solution to live withdrawal of addresses from field visits due to responses and refusals did cause more issues in the monitoring of the overall field operation, covered in the observations section below.

15. Officers then had to upload their day's work by 10pm, so that the scheduling could run overnight. There was a rule that visits to the same address had to be at least 2 days apart – this worked as expected when an officer uploaded on time. However, if an officer didn't upload their day's work on time, all cases were assumed incomplete and might be rescheduled for the following day.

16. The FWMT system had an associated Management Information package, that was set up to draw out operational data from which HQ and coordinators would monitor and manage operations. The intention was that coordinators would essentially use the data to ensure officers were keeping to procedures, and offering training interventions where necessary, while HQ could monitor whether the higher level targets were being met across all the areas, for example numbers of visits per day, and the effect on return rates.

17. An outcome was captured for each visit (including where contact was made), which provides vital information on calling patterns and contact success rates which we have not had before, and which will be used for planning for 2021.

² Note that this was for the voluntary test only. However, in a mandatory census there may be cases where an address is taken off the field follow-up list if the refusal is threatening.

III. Observations from the 2017 Test

3.1. Operation of the integrated systems

18. The systems worked very well together, barring some minor teething issues that were resolved swiftly. For the 18 weeks that the system was live, an uptime of 100% of both the applications and the environment was achieved, 24 hours a day, 7 days a week. All support was provided by the team, who were able to perform any necessary changes during live running with no downtime. The system was able to meet demand during periods of high call volumes, and remained responsive and functioned as expected even during peak call times. In addition, the benefits of re-using existing services was demonstrated as the GOV.UK Notify service was used to send email to the support team and SMS messages to respondents for replacement secure access codes. The on time delivery of the infrastructure and applications, and subsequent 100% uptime of a newly deployed complex system represent a significant technical achievement.

3.2. Minimising wasted reminder letters

19. Returns submitted via the online eQ were marked as complete in RM as soon as they were submitted. This then closed the address down and it got no further actions. This is one of the major advantages of a 'real time' system using electronic collection. However, if an electronic return was submitted after the reminder letter cut of non-responding households was taken, it was not possible to recall the letter from the printer. This happened for between 1 and 3 percent of addresses for the 3 reminders, and while not ideal in these cases, is a large improvement on previous census experiences.

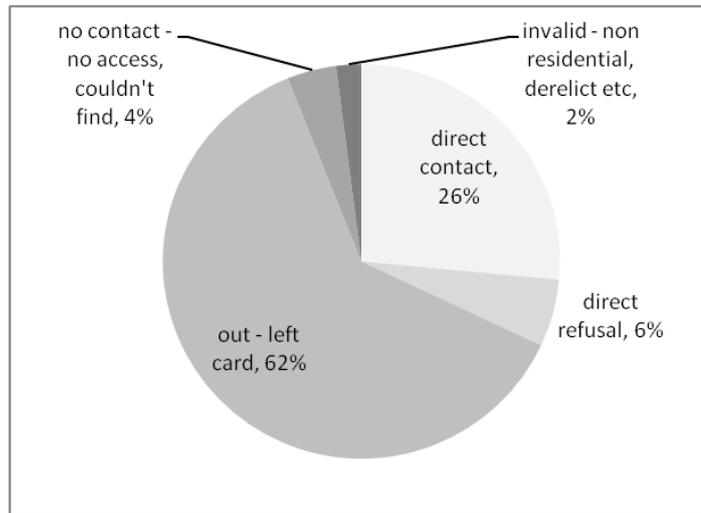
3.3. Minimising wasted visits because someone has already responded

20. One of the advantages of electronic collection and a response management system is that responses are receipted and taken off follow-up lists before we waste money on a field visit. This was apparent in 2017, with the only exception being around the receipt of individual forms that did not stop further visits. These are available to anyone in the household, but it is the household form that we follow up, because this contains the dwelling, relationship and bulk of individual data. This therefore is an unavoidable situation that a system doesn't need to solve, but is rather a case for our messaging to householders on what they are required to return.

21. Wasted visits after households had posted their paper responses was more common, and is an aspect that could be addressed by leaving a lag before visits are scheduled.

3.4. Inconsistent field outcomes

Figure 2
Field visit outcomes in 2017 Test



22. Figure 2 shows the breakdown of field outcomes from the 200,000+ visits in the test. Detailed interrogation of the fieldwork management data showed that a small number (just over 1,000) of 'invalid' or 'no contact' addresses did have personal contact at some point before a visit produced this outcome – for example an officer made contact on the first visit, then the property was noted as derelict on the next visit. These are the extreme cases of inconsistent outcomes – there were other examples, including officers finding 'undeliverable as addressed' dwellings that had had some form of mail returned by the postal service.

3.5. Linking paper questionnaires given out in the field

23. Field staff applied a manual process to record paper questionnaires to addresses, but this was open to error and required significant resource to resolve. Furthermore, the time taken to resolve and match paper questionnaires to addresses meant most weren't completed until after field operations had ceased. This led to a number of respondents continuing to receive reminder letters and field visits despite already having responded.

3.6. Withdrawals – tactical solution

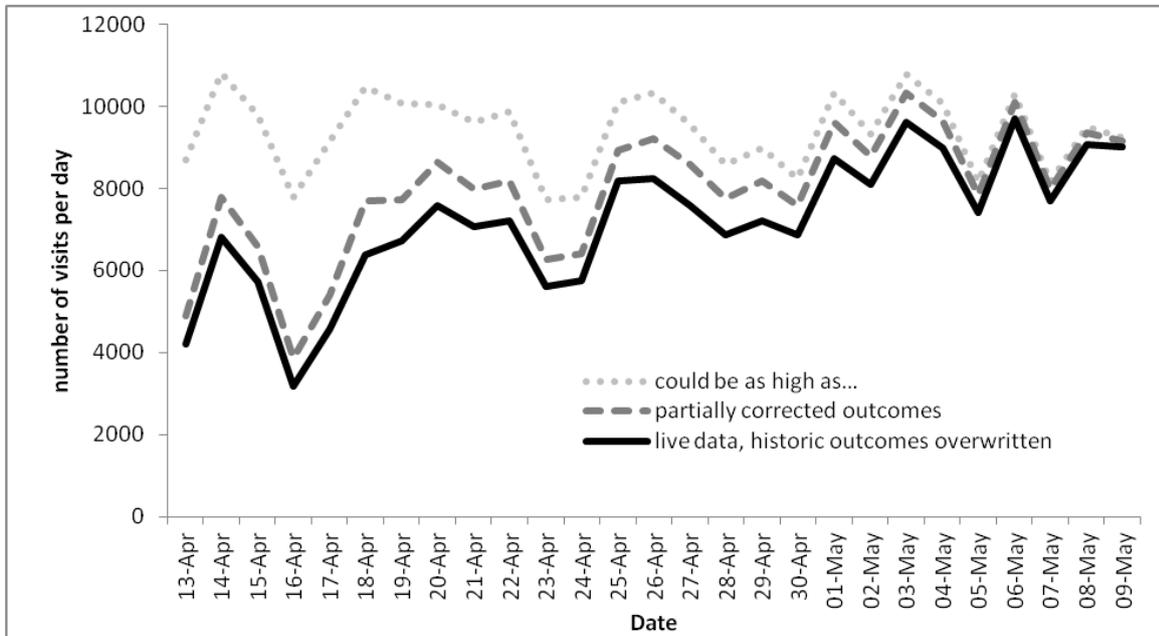
24. As mentioned above, if an address returned or refused via the helpline, a 'withdrawn' message would go to the relevant work schedule to update the visit. However, this message would overwrite the entire visit history of the record in the data that we had live access to. There was also confusion about whether 'withdrawn' flagged visits had happened or not, as the record was marked as 'complete' regardless.

25. The result of this was that using the current scheduler data on any one day would show incorrect numbers of visits (if all withdrawals were excluded) for that and previous days - and numbers of visits kept reducing for historic days each new day the data were loaded.

26. Even if withdrawals were included and the completed flag used, the visit outcome for the final visits in these cases were overwritten with the withdrawn flag. So, for instance, we couldn't see whether contact was made, a paper questionnaire given out, etc.

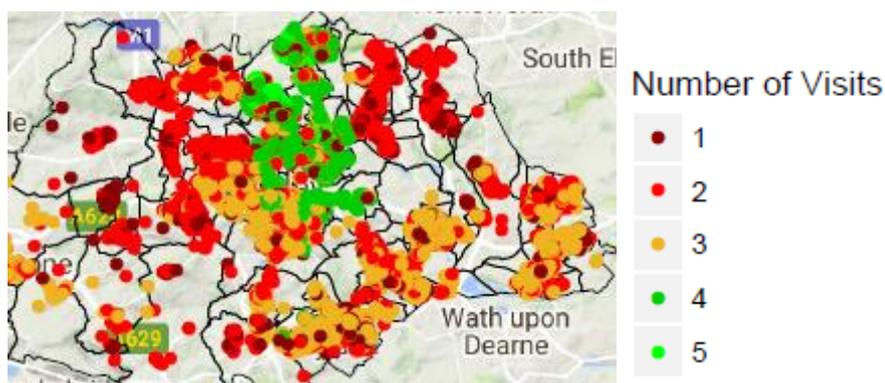
27. This was fixed in a tactical way live by taking live extracts of the scheduler data a couple of times a day and fixing withdrawal outcomes with the last known actual outcome, and the final data set made use of the full 'job manager' background data which kept the full record of every visit and action. Live, however, there was frequent confusion in the management information creation process, as the visit number history kept changing. Figure 3 demonstrates the impact of this up to the end of the field period.

Figure 3
Field visit outcomes in 2017 Test



28. This also had the consequence that it wasn't clear during the operation that some addresses were not getting the same number of visits as others, and that this was happening in clustered areas. We are still investigating this issue, but Figure 4 below demonstrates this for one of the main test areas.

Figure 4
Field visit outcomes in 2017 Test



3.7. Information gathered

29. Among the key aims of the 2017 Test were objectives to gather information on field effectiveness and calling patterns, and to demonstrate the effectiveness of the integration of

electronic collection and operational data. These aims have been met, with successes in reducing wasted visits and a vast amount of information gathered on field calling patterns and effectiveness, which has not been available to this extent before.

IV. Lessons learned

4.1. Operation of the integrated systems

30. We will be continuing to develop the systems up to 2021, considering what other parts of the operation will need to feed, and benefit from feeding, RM.

4.2. Reminder letters

31. In order to minimise wasted reminder letters, we need to consider which populations are most likely to respond because of the reminder but also are highly likely to need that prompting. This will hopefully minimise the number of wasted reminders. We are using data from the 2017 responses to try and predict where these populations will be in 2021.

4.3. Wasted visits

32. As we do a census of housing and population, we need to follow-up the entire household form. To this end we still keep actions open even if an individual form has been received. This caused some confusion for individuals who insisted that they had completed – our lesson learned here is around messaging.

33. To minimise wasted visits due to the lag in receiving paper questionnaires through the post, we recommend that a lag is built into field follow-up to allow for this time. Observations from the test demonstrate that 7 days would give an adequate buffer for receipt before further actions are invoked from a request for a paper questionnaire, or 5 days after a form is given out in the field.

4.4. Inconsistent field outcomes

34. This highlights the need for more training of officers, and an independent source of information to validate such outcomes. Due to other issues that coordinators had to deal with in the first week of follow-up, very few coordinators accompanied their teams as planned. This would usually be part of the field officer training, and the test demonstrated that there would be a real benefit to field effectiveness if this additional training can be flagged live and fed back to officers swiftly. We are looking at ways to integrate independent validation as an integrated step in 2021.

4.5. Linking paper questionnaire

35. The procedures used in 2017 will not be those for 2021, but was a reminder of a similar lesson learned in 2011, which we need to be better prepared for. A key assumption of the 2021 Census operational design is that field staff will be able to digitally link paper questionnaires to addresses at the point of issue, and that information will be passed to the response management product to ensure the efficient management of cases and action plans.

4.6. Withdrawals

36. The lesson learned here is to complete thorough testing of the system, and to understand fully the implications across integrated tools of any tactical solutions employed in one.

4.7. Key lessons

37. As well as the points covered above, key lessons from the 2017 test include:

- Beware of a glut of data and the time it takes to prepare and interrogate it adequately – it is too easy to get weighed down and distracted in preparing the wrong indicators, or demonstrating clever aspects of what we’re learning that don’t answer the key questions. We need to be clear on the actions available and decisions/information needed to make these.
- Do adequate testing to understand the quirks of the systems and any tactical ‘workarounds’ that have to be implemented.
- Be adaptable with MI, have some pre-packaged but be prepared for anything when dealing with public response and field officers’ use of procedures.
- Make best use of the tools available – we have subsequently mapped addresses by response outcome and field outcome for each day of the collection operation, which demonstrates patterns more clearly than the pre-canned MI. We are looking at ways of providing this for the 2019 Rehearsal and 2021 Census, and what aspects of the operation they would be most helpful for.

V. Conclusion

38. The 2017 response management scope was successfully delivered and provided assurance that it could be extended to support ONS business and social surveys, including the 2021 Census. The development of the 2017 response management product has been recognised as an exemplar within ONS of collaboration between business areas and internal Digital Services and Technology teams. The integration with the helpline, sending address lists to the printers for reminders, and taking in paper questionnaire receipts also worked well and added to the wealth of information available to HQ during the collection operation.

39. RM, eQ, FWMT worked well together, and the information available to us during the collection operation is a huge improvement on 2011. This is largely possible due to having online responses taken off so quickly, but also having access to daily information on progress in the field, both being able to feed into logical action plans.

40. There are clear improvements we can make to validate the way returns and refusals are removed from future follow-up actions, and have lags to allow for paper questionnaires to be posted and receipted before a field visit or reminder is instigated. More work is needed to link paper questionnaires given out in the field, and all of the activities need to be thoroughly tested.

41. The key lesson from this test, however, is to beware of getting weighed down by too much data, and to thoroughly understand what the main indicators are in whether we are meeting our targets. Mapping outcomes have helped us retrospectively, and we are looking into how we can use these in 2021 across the entire operation. Even so, we will need to develop some automatic techniques in order to spot where issues are developing.

VI. Plans for Taking Further

42. Since the 2017 Census Test, the ONS response management product has already been extended to support a number of business surveys. Census teams will work closely with experts from business and social surveys, together with Digital Services and Technology teams, to ensure the development of a corporate response management product that is capable of supporting the variety of ONS surveys. Work is currently underway to identify synergies in requirements across census, business and social surveys. A gap analysis will also be undertaken to identify any functional and non functional requirements unique to the 2021 Census.

43. The 2019 Census Rehearsal will provide the next key test of census requirements for response management. The most significant challenge here will be the integration of the product with numerous internally and externally provided products/services, whilst supporting the volumes and timeliness a census operation requires.

44. Management information requirements are still being scoped out, but a high degree of flexibility and facility for manipulating the base data and, for example, mapping outcomes are key needs.

45. For our fieldwork management tool, we are currently working on specifying what it needs to include as a minimum viable product for the 2019 Rehearsal. As well as learning from the above observations, there will likely be less emphasis on visit by visit scheduling, and more allowance made for giving field officers a set of addresses and allowing them to organise their own routing.
