Findings and Recommendations for Cognitive Testing of the 2019 Annual Business Survey

Contents

Executive Summary

In September 2018, Krysten Mesner and Struther Van Horn from the U.S. Census Bureau's Data Collection and Methodology Research Branch (DCRMB) conducted 18 cognitive interviews on an existing survey: The Annual Business Survey (ABS). The ABS asks questions about the business owner(s) as well as various characteristics about the business. The cognitive testing included testing general questions about company information, research and development (R&D) questions, as well as a new technology module. The first round of testing showcased areas of strength for the survey, as well as some areas that can be improved upon. A primary strength of the survey is that many of the respondents understood the terminology used throughout the survey. Additionally, many participants indicated that they were able to complete the survey in the allotted amount of time, which is always a concern. The main area of concern for the survey which will require improvement is defining and providing consistency with both the terminology used and the directions provided.

Research Objectives

The ABS asks questions about the business owner(s) as well as various characteristics about the business. The 2019 ABS cognitive testing will include some general questions from section A and research and development (R&D) questions from Section D of the ABS as well as a new technology module. The types of questions in the R&D and technology module are listed below:

- Intensity of Use asks about the intensity of usage of different technologies during the recall period (three years including 2016-2018).
- Motivation for Technology Adoption and Utilization asks about the reasons behind adoption and utilization of the technologies.
- Impact of Technology on Workforce is designed to understand how each technology helped reorganize the responding company's workforce during the three years 2016 to 2018.
- Impact of Technology on Worker Types assesses the impact of each technology for different worker types.
- Factors Adversely Affecting Technology Adoption and Utilization asks about how different factors adversely affected the adoption or utilization of specific technologies from 2016 to 2018.
- Research and Development asks about R&D activities. These data are used to compare R&D costs across industries, determine where R&D activity is conducted geographically, and identify the types of businesses with R&D.

The objectives of these interviews were to learn the following from participants:

- how they understand and interpret the questions that they are being asked to respond to;
- if the answer choices that they are provided are appropriate for their respective question;
- if there are any questions that cause the respondents difficulty;
- if there are any order or context effects that impact respondents' ability to answer the questions

Results of this testing will be used to refine the questions as the survey enters the next stage of development.

Research Methodology

To address the research objectives, 18 interviews were conducted in total, between September 10th and September 21st, 2018. Potential participants for the interviews were found using a list of respondents from the 2017 ABS. During the recruitment phase, participants were asked screening questions to ensure that they meet the criteria for testing the technology module questions on artificial intelligence, cloud-based computing systems and applications, specialized software, robotics, and specialized equipment. The persons of interest for these interviews were the respondents who had previously completed the 2017 ABS, which included business owners, presidents, chief executive officers, chief financial officers and managing partners.

Potential participants were contacted via email and asked if they would like to help review draft survey questions and provide feedback on their experience completing the 2017 ABS. Interviews were conducted in-person. Table 1 summarizes the number of interviews conducted in each metropolitan statistical area:

Table 1. Number of interviews per metropolitan statistical area (MSA)

MSA	# of Interviews
Los Angeles, CA	9
New York, NY	9
TOTAL	18

Given the different modules being testing on both R & D and technology, efforts were made during the recruiting process to get participants from a range of different industries. Table 2 summarizes the number of businesses that participated in each industry sector, based upon classification by the North American Industry Classification System (NAICS):

Table 2. Business Industries

Industry Sector	# of Businesses
31- Manufacturing	1
44- Retail/Trade	4
51- Information	1
54- Professional, Scientific, and Technical Services	11
62- Health Care and Social Assistance	1
TOTAL	18

Efforts were also made to get variety in the size of businesses recruited. Table 4 provides a summary of the number of businesses that participated, based upon business size by the number of employees:

Table 3. Size of Businesses

Business Size	Count
1 to 4 Employees	8
5 to 9 Employees	5
20 to 49 Employees	2
50 to 99 Employees	2
100 to 249 Employees	1
TOTAL	18

Efforts in recruitment were made to get a variety of businesses based upon their responses to the 2017 ABS on technology and R&D questions. Table 4 provides a summary of the businesses that participated based upon their responses in the 2017 ABS to technology and R & D questions. Additionally, this information also helped determine which modules would be tested with the respondent:

Table 4. 2017 ABS Responses

	Count
R&D*	11
Robotics*	7
Artificial Intelligence*	7
Other Technology*	4

*Note, a business could indicate they used multiple technologies (robotics, artificial intelligence, or other) and R & D.

Table 5 summarizes the number of businesses that completed cognitive testing for each module:

Table 5. Modules Tested

Module	Partial Complete Count	Complete Count	TOTAL
2017 ABS Review	0	18	18
Company Information Module	0	18	18
R & D Module*	8	9	17
Technology Module*	3	15	18

*Note, some businesses were only able to complete a module partially, due to either time constraints or applicability of questions. Partial completes indicate a business was only able to answer some questions in a module, complete count indicates a business answered all questions applicable in a module.

Cognitive interviews were the testing methodology used for this project. Cognitive interviews are used to, "(a) understand the thought processes used to answer survey items, and (b) to use this knowledge to find better ways of constructing, formulating, and asking survey questions" (Forsyth and Lessler, 1991).[1] Cognitive interviews traditionally focus on the four steps of Tourangeau's (1984) cognitive response model: comprehension, retrieval, judgment, and communication/reporting.[2] Comprehension refers to the participant's interpretation and understanding of the question's language, structure, and grammar. In order to answer the question, a participant must understand what information is being requested on the survey. Retrieval is the step where relevant information is obtained, either from records or from memory. The next step, judgment, describes the participant's evaluation of the completeness or relevance of the data obtained. It is here that estimates are made based on partial or incomplete data. The last step, communication or reporting, deals with mapping the response to the answer space provided and possibly altering the answer.

While Tourangeau's model is suitable for household and social surveys, the establishment survey setting presents additional factors that must be considered. First, instead of or in addition to a reliance on memory, establishment surveys rely heavily on records and the information contained within them. Second, organizations tend to have distributed knowledge. Some people are experts in one type of information, while others keep information about something else. Third, competing priorities, both for the organization and the individual(s) completing the questionnaire, mean that the survey sometimes does not receive the amount of attention that researchers and data collectors would like. Finally, organizations regularly authorize only a few individuals to release data. If the data provider is not authorized to release the data, an additional step must be added to the response process. Tourangeau's model was expanded by Sudman *et al* (2000) to account for these factors. [3]

[1] Forsyth, B.H. and Lessler, J.T. (1991). "Cognitive Laboratory Methods: A Taxonomy." In Measurement Errors in Surveys, P.P. Biemer, R.M. Groves, L.E. Lyberg, N.A. Mathiowitz, S. Sudman (eds). New York: John Wiley & Sons, Inc.

[2] Tourangeau, R. (1984). "Cognitive Sciences and Survey Methods." In Cognitive Aspects of Survey Methodology, T.B. Jabine, M.L. Straf, J.M. Tanur, and R. Tourangeau (eds). Washington, DC: National Academy Press.

[3] Sudman, S., Willimack, D.K., Nichols, E., and Mesenbourg, T.L. (2000). "Exploratory Research at the U.S. Census Bureau on the Survey Response Process in Large Companies." Paper prepared for presentation at the Second International Conference on Establishment Surveys, Buffalo, NY.

Findings and Recommendations

General Findings

Finding #1: Difficulty with use of multiple time frames within the survey

The use of several different reference years and dates throughout the survey made it difficult for respondents to clearly answer many of the questions. Some questions ask for information from a single year while others ask for a recall period of three years. While respondents did not have difficulty answering questions that called for a three-year response period, they did often indicated that they would be thinking of the current year when answering these questions. Additionally, respondents had the most difficulty with the questions that asked for information for the specific date of March 12th. Every respondent interviewed questioned the usefulness or need for the March 12th date. The use of several different reference periods creates additional cognitive burden on the respondents as they go through the survey.

Recommendations:

- For ease of burden and consistency, consider using just one reference frame throughout the survey. The easiest for recall and burden may be the prior year or the current year.
- If it is determined that multiple dates should stay, consider not including the March 12th date, unless there is an administrative/data editing need. More details on this in the item-specific findings.
- Additionally, if multiple reference dates are used throughout the survey, we recommend insuring that there is a clear indication of the change of the reference period in the instructional text or question(s).

Finding #2: Inconsistency with reporting instructions

Several questions in the Research and Development module were missing clear reporting instructions on whether the respondents should be providing dollar amounts or percentages. Questions 4, 5, and 6 used ambiguous instructions such as “the amount” or “how much was paid”. Respondents indicated that they would be able to provide either dollar amounts or percentages in cognitive testing.

Recommendation: Ensure that there is consistency in asking respondents to report in either dollar amounts or percentages. The reporting instructions should be consistent for all applicable questions (e.g. questions 4 through 6 in the R & D module) and clearly state if dollar amounts of percentages should be reported.

Finding #3: Inconsistency with providing a reference period in each question

Several questions were missing a reference period, which made the questions difficult to respond to. Consistent use of a reference period should be used throughout the survey. Respondents indicated that they would either have to guess at which reference period to report for or use proceeding questions to help guide them in determining a reference period.

Recommendation: For the following questions, specify a reference period or date in the question text: question 3 in the Company Information Module and questions 3, 4, 5, and 6 in the R & D Module.

Finding #4: Missing definitions for key terms

Several of the questions throughout the different modules were missing definitions for key terminology that would help respondents answer the questions and ensure they were including the correct information. These terms include, owner, employee, and worker.

Recommendation: provide definitions of the following key terms:

- In the Company Information Module, given the way that the questions ask about ownership, provide a definition of owner with question 2.
- In the Company Information Module, R &D Module, and Technology module, provide a definition of the term employee and worker the first time the term is used in each module.
- Additionally, these terms could also be defined with the overview information of the survey or individual modules.

Finding #5: Inconsistency with use of terminology for those working for or paid by the business

In the Business Overview Module, the term employee is used to discuss people who worked for the particular business. In the R&D Module, the term employee is also used. In the Technology Module, the terms worker, production worker, non-production worker, supervisory worker, non-supervisory worker, and skilled worker are used. While most of the participants understood what was meant by the terms employee and worker, it was difficult for respondents to think of multiple terms for the same concept.

Recommendation:

- Use of either the term employee or worker consistently throughout the modules on the survey.
- If both the terms employee and worker are to be used, clearly define the terms when the terms are first used. This appears to be particularly important given the inclusion or exclusion of owners as employees/workers. It may be beneficial to provide a clear include/exclude list for these questions to help clarification for the respondents.

Finding #6: Question order could be improved

We recommend reviewing the order of questions in the survey to see if question order could be improved upon, to ease cognitive burden on respondents. The placement of the Business Sales question within the Research and Development Module did not to fit with the rest of the questions in the module. Additionally, it may be beneficial to review the question ordering within the Technology Module, as it may be more beneficial to move question 9 up with the other questions asking about motivation for use of technologies.

Finding #7: Question headers/titles sometimes created confusion

For some of the questions, the question headers or titles created confusion for participants on what the question was asking and how they should be answering the question. For example, question 4 in the Company Information Module, has a header/title of “Number of Employees” but then asks about the number of non-owner employees, which created confusion for respondents.

Recommendation:

- Remove question headers/titles so that participants can focus more on the question instead of the question header when answering questions.

If question headers/titles are to be used, consider reviewing the information to ensure that it matches with the information being asked for in the question, to reduce confusion and cognitive burden.

Item Specific Findings

Company Overview Module

Number of Owners

Finding #8: Difficulty in separating spouses as owners

Some participants brought up difficulty in separating spouses as owners for this question. A participant specifically questioned why married partners were to be counted separately while other agencies (e.g., SBIR grant system) counts married couples that invest jointly as individuals.

> **Recommendation**: We should consider not separating out spouses necessarily as separate owners as spouses are often specifically only considered as 1 owner when investing, particularly for when looking at percentage of owners as women. We need to ensure that we are measuring the correct concept with respect to married couples that jointly invest.

Number of Paid Owners

Finding #9: The reference period/date is missing from this question

For the Number of Paid Owners, the reference period/date is missing from the question. Some participants asked what time period this question was asking about.

> **Recommendation**: Specify the reference period (2017) that is being asked about in this question.

Number of Employees

Finding #10: Participants found it burdensome to report for March 12, 2017 reference date

The March 12, 2017 date poses difficulty in that there's extra burden to look up payroll information for that pay period. Participants didn't understand why this date as it doesn't coincide with year-end or quarterly reports. Most employees stated that they have a year end 1099 report that they could look up and easily reference.

Recommendation: Although the March 12, 2017 date coincides with the IRS payroll date, we should consider reducing burden on the respondent and changing date to 2017 as opposed to a specific date.

Finding #11: Reference date of March 12, 2017 may not be representative of actual number of employees

Given this reference date of March 12, 2017, categories A and B may not be representative of the actual number of employees that they have (several respondents mentioned this wouldn't account for seasonal employees such as summer interns).

Recommendation: Consider changing the reference date to 2017.

Finding #12: Difficulty answering for employees who are owners

Respondents found it confusing to have the title of the question "Number of Employees." The instructions were unclear when instructing respondents to "Include both full-time and part-time workers as well as yourself." This was problematic for owners completing the survey.

Recommendation: If the sponsor wants the question to ask about non-owners, the instructions need to change. The header could be changed to "Number of Non-Owner Employees." The instructions should be reworded to say "include yourself only if you are not an owner." Or, just remove header for "Non-Owners Number of People."

Finding #13: Response categories for employee types are not exhaustive to reflect state regulations

One respondent questioned the legality of having unpaid employees; NYC prohibits unpaid employees. They are, however, allowed to have volunteers. Several firms did have volunteers and one specifically mentioned the pay period of March 12 would miss all of their volunteers.

Recommendation: Add the term "volunteer" as some companies have volunteers instead of "unpaid interns" per state laws. Keep 1099 and Unpaid workers in separate question. Call them "workers" and not "employees."

Total Sales and Revenues

Finding #14: Question and instructions unclear for Total Sales and Revenues question

Some participants experienced confusion and burden when responding to this question. One participant wondered if this included their venture funding.

Recommendation: Provide examples of the types of things to include and exclude.

Finding #15: Reporting for a calendar year instead of a fiscally driven year can create added burden for a respondent

A participant indicated that they were not easily able to report this because their company is fiscally driven with an August 31st fiscal year, but Census wants a calendar year which required them to pull 12 months of revenue.

> **Recommendation**: None

Domestic Sales and Revenues

Finding #16: Question header for Domestic Sales and Revenues question created confusion

Most considered that they had foreign sales due to selling products outside of the US. It was not until they looked at example/definition did they change response. It really seems to be an issue of production vs sales. This question really seems to be looking at production sales/revenue as opposed to just domestic sales. Almost all respondents initially said yes to foreign sales until looking at example provided. "Where the operations took place is confusing."

> **Recommendation**: Perhaps change title of question or remove question title per the recommendation for Finding #7. We could define domestic/foreign sales first or even switch order of questions 5 (Total Sales and Revenue) and 6 (Domestic Sales and Revenue), could combine questions 5 and 6 into one question, or screen respondents out of foreign sales/revenue prior to getting questions 5 and 6.

Research & Development Module

Finding #17: No definition is provided for R&D

There is no definition of R&D provided for participants in the content testing.

> **Recommendation**: R&D should be written out and defined at least once in the module. It is provided in the web survey instrument. It should also be provided on the paper instrument for participants in future content testing.

R&D Costs

Finding #18: Expand on what should and should not be included here

One participant struggled whether patent costs should be included or not here.

> **Recommendation**: Provide guidance on whether or not to include or not include patent costs here.

Funding Sources for R&D Activities

Finding #19: The response category "This U.S. Business" is odd

"This U.S. Business" was a little odd and participants had to reread as it seemed strange when they first read it.

> **Recommendation**: Revise response category a. to "Your U.S. business."

Finding #20: More guidance on how to answer for investors is missing from R&D funding sources question

Participant unsure of how to answer for investors as their largest portion of funding comes from investors.

> **Recommendation**: Provide more guidance for respondents.

Finding #21: Reference period/year missing for some questions

Questions 4-6 (Funding Sources for R&D Activities, Percent Paid for R&D Conducted by Others, and R&D Categories) are missing the year we'd like respondents to report for.

> **Recommendation**: Provide the year that we would like them to report for in the directions.

Finding #22: Respondents have a preference to report in dollar amounts instead of percentages

Participants reported that they could report in either dollar amounts or percentages for Questions 4-6 (Funding Sources for R&D Activities, Percent Paid for R&D Conducted by Others, and R&D Categories). They indicated that dollar amounts would be relatively easy to obtain from their records. Some participants said that they would give a ballpark estimate if asked for a percentage or if they wanted to give a more exact percentage that it would require an extra step of calculating from the dollar amount.

> **Recommendation**: Instruct respondents to report in dollar amounts for these 3 questions.

R&D Employees

Finding #23: It is unclear whether owners should be included in the R&D Employees question

There are no instructions provided on whether owners should be included in the response for this question.

> **Recommendation**: Specify in the instructions whether owners should be included. Are we interested in capturing all W-2 and 1099 employees? We should be defining employee here.

R&D Employee Occupations

Finding #24: Reporting education level for each R&D employee would create burden for larger companies

Smaller companies had no issues responding to this question. However, larger companies mentioned that they wouldn't have the ability or time to ask each employee about their education level.

> **Recommendation**: None

Finding #25: It is unclear whether owners should be included in the R&D Employee Occupations question

The question instructions do not specify if owners should be included in the response or not.

> **Recommendation**: Specify in the instructions whether owners should be included. Are we interested in capturing all W-2 and 1099 employees? We should be defining employee here.

BUSINESS SALES

Finding #26: Nearly all participants unable to respond to the Business Sales question

This question created significant difficulty for participants for several reasons. The grid as written is not clear and while most understood the concepts being addressed there was cognitive burden associated with the layout. None of the respondents we met with would be able to respond to the question how it's currently written.

> **Recommendation**: This question should be dropped or reworked completely.

Finding #27: Some participants unable to provide the information since they don't mark sales in this way

Most respondents reported that they could not quantitatively answer this question and any information provided would be a guess.

Recommendation:

Finding #28: Dates in question are inconsistent

The question asks for total sales in 2018 but then asks about 2016-2018, which is confusing

Recommendation: The time period in question should be consistent.

Finding #29: Not clear what question is asking about

One respondent said they thought the question was asking about new versus older products, which could be responded to, however, the multiple years and aspect of "between products" and identical/similar products to competitors is unanswerable.

Recommendation:

Finding #30: Question not applicable for companies that don't have sales

Some participants were especially confused and said that they don't have sales. They were unsure of how to answer given this fact.

Recommendation: Consider adding a check box at the top for Not applicable for companies that don't have sales.

Technology Module

Finding #31: There is an overlap between specialized software and cloud-based computing systems and applications

Many respondents had difficulties separating out responses for specialized software and cloud-based computing systems and applications as they can be both.

Recommendation: Provide an instruction for respondents not to include cloud-based computing systems and applications as specialized software.

Impact of Technology on Workforce (Process and Methods)

Finding #32: Unclear whether the question is asking about hiring employees or current employees

It's unclear whether we are looking at hiring vs. current employees impact on skill level.

> **Recommendation**: We should decide what we're trying to ask about here and reword the question to make sure that we can capture it.

Impact of Technology on Worker Types (Process and Methods)

Finding #33: There is no definition of "employee" for this question

The definition of employee is missing here. There is an issue of different workers, particularly production workers and non-production. Respondent would have to read through all the options to better understand where each type of worker should be included. Do we want W-2 or 1099 or both?

> **Recommendation**: Provide a definition for employee.

Technology Based Goods and Services

Finding #34: Question wording is confusing, particularly the part about included/embedded

The question wording is confusing as it isn't clear what is meant by "included/embedded" the technology given the proceeding qualification.

> **Recommendation**: Simplify question and broaden scope by dropping "or embedded."

Motivation for Technology Adoption and Utilization (Goods and Services)

Finding #35: Question wording is confusing, particularly the part about included/embedded

The question wording is confusing as it isn't clear what is meant by "included/embedded" the technology given the proceeding qualification.

> **Recommendation**: Simplify question and broaden scope by dropping "or embedded."

Factors Adversely Affecting Technology Adoption and Utilization

Finding #36: Participants experienced difficulties understanding that question is asking about reasons for not adapting

Many participants had difficulties understanding that the question is asking about reasons for not adopting. However, many respondents responded for technologies that they have already adapted.

> **Recommendation**: Determine what we're actually trying to capture here.

Finding #37: Some participants struggled with the language of this question

Some respondents struggled with the language – specifically, having to read the question as a negative and then apply the negative to the categories. One expressed preference for negating the categories directly (e.g., "Costs" becomes "Too expensive", "Access to talent" becomes "Difficulty hiring talent" etc.). Others struggled with the time frame. Others struggled with how to respond when nothing adversely affected their technology adoption. Some struggled with how to respond when they hadn't considered the technology for their business or it was not applicable to their business during this time frame.

> **Recommendation:** If possible, consider making category headers "negative" to reduce cognitive burden.

Finding #38: Question categories could be improved for this question

Categories were typically accepted. Many could not uncover the meaning of "Standards and Accreditation"; some thought they meant generically industry standards or standard business practices. Others mentioned laws such as HIPAA yet didn't associate that with reasons for not using the technology (cloud.) Many mentioned privacy concerns yet not all selected "security" category for reporting. Many reported that "Access to capital" is the primary reason for (small) businesses not adopting more technology.

> **Recommendation:** Remove the "Standards and Accreditation" category as it is poorly understood. Add "Access to capital" category.

Finding #39: Modify "None" category

The "none" category seemed to catch both people who did not have things adversely affecting their technology and those who did not adopt the technology for a variety of reasons.

Recommendation: Change the "None" category to something along the lines of "No factors adversely affected adoption" for those that adopted technology. Add something like "N/A" or "Did not consider this technology for my business" for those that did not adopt or consider adoption.

Finding #40: Confusion over whether question was referring to their product, not the process

Both respondents that produced and used technology thought that this question was referring to their product, not process.

Recommendation: Move question 9 after questions 1-4 as it relates to process not products.

Appendix A: About the Data Collection Methodology and Research Branch (DCMRB)

The Data Collection Methodology and Research Branch in the Economic Statistical Methods Division (ESMD) assists economic survey program areas and other governmental agencies with research associated with the behavioral aspects of survey response and data collection. The mission of DCMRB is to improve data quality in surveys while reducing survey nonresponse and respondent burden. This mission is achieved by:

- Conducting expert reviews, cognitive pretesting, site visits and usability testing, along with post-collection evaluation methods, to assess the effectiveness and efficiency of the data collection instruments and associated materials.
- Conducting early stage scoping interviews to assist with the development of survey content (concepts, specifications, question wording and instructions, etc.) by getting early feedback on it from respondents.
- Assisting program areas with the development and use of nonresponse reduction methods and contact strategies.
- Conducting empirical research to help better understand behavioral aspects of survey response, with the aim of identifying areas for further improvement as well as evaluating the effectiveness of qualitative research.

For more information on how DCMRB can assist your economic survey program area or agency, please contact the branch chief, Amy Anderson Riemer.

Appendix B: Cognitive Interview Protocol – 2019 Annual Business Survey

DRAFT Cognitive Interview Protocol - 2019 Annual Business Survey

Research Questions to Address:

- Are respondents able to answer the questions as intended?
- Are there any items that cause the respondents problems?
    - What can be done to fix those problems?
- Are there any order/context effects?

Materials:

- Copies of questionnaire testing draft
- Recorder, batteries
- Consent form

Procedure:

- Go through the Introduction and Before the Questionnaire questions.
- Then provide R with the draft questions (Attachments B, C, and D) and ask R to fill it out. Once R completes each question, ask the general probes and any item-specific follow-up probes.
- Note how R navigates the questionnaire and if they appear to be having any difficulty with the questions. If R appears to have any problems (utterances like "Hmm", confused looks, etc.), probe on this.
- Go through probes about Wrap-up Questions

Introduction:

- Explain purpose of meeting: to obtain feedback on reporting to the 2017 ABS, to understand the process of answering questions, and to evaluate how new questions work or don't work.
- Some questions I will ask may seem odd and/or obvious, but I don't want to assume I know what you are thinking.
- Explain that we are *not* testing the respondent – we only want to evaluate the questionnaire
- Structure of meeting: Understand your business and your role in it, then review the questionnaire and ask you questions as you complete it.
- Permission to record discussion for note taking purposes? This study is being conducted under the authority of Title 13 USC. We plan to use your feedback to improve the design and layout of the form for future data collections. Only staff involved in this product design research will have access to the recording. Have R sign consent form.

Before the Questionnaire:

- What types of goods or services does this business provide?
- What is your role in the company? What kind of responsibilities do you have?
- Are you one of the owners of the business?

- Have you completed other surveys from the Census Bureau or other agencies? If so, which ones?
- What was your role in the process for responding to this questionnaire? *(Gather data? Enter data? Consult with data providers? Etc.)*

Questionnaire test
Now let's take a look at the draft questions. I would like you to go through and answer the questions as if you were filling out an actual form. If you don't have answers to any particular questions, you can just make a best guess. I will ask you some questions as we go through them.

These questions are intended for [name of business as listed in recruiting file].

General Probes:
- What does this question mean to you?
- How did you go about answering this question?
- Would you be able to answer this question yourself? *(If no)* Who would be the appropriate person to answer it?
- *(If R appears to have problem/confusion)* What are you thinking about?
- *Reflect R's specific answer:* You said ___. Can you tell me more about that?
- *If R notices skip instructions:* The electronic system would skip automatically, but we will go over every question to make sure they are all clear.
- How do you feel about the order or flow of the questions being asked in the survey?

Item-Specific Probes:

<u>Company Information</u>

<u>10% or More Ownership</u>
- What do you think this question is asking?
- Are the instructions clear?

<u>Number of Owners</u>
- *For respondents that selected No to the 10% or more ownership question,* how did you come up with your response?
- Does the March 12, 2017 date affect your ability to answer the question? If yes, what are the reasons?

<u>Number of Paid Owners</u>
- What's the difference between this question and the previous (number of owners) question?
- Are you easily able to report this?

- *If response to number of owners and this question is the same,* how would you respond?

Number of Employees

- What's the difference between the previous (number of paid owners) question and this question?

Total Sales and Revenues

- Are you easily able to report this value for the entire business?
- Do you believe that the question is asking about worldwide sales and revenue (outside US and domestic) or only domestic sales and revenue?
- Does your company have foreign sales and revenues?
- In what dollar unit did you report?
- How do you feel about being asked to report dollar the amount in thousands?

Domestic Sales and Revenues

- How did you come up with your response?
- In what dollar unit did you report?
- What do you think this question is asking about? Do you think it is asking about the domestic portion of the value reported in Total Sales and Revenue question?
- *If response to Total Sales and Revenues and this question is the same (meaning only domestic sales),* how would you respond?
- How do you interpret the phrase "attributable to or originated from domestic operations"? Does that help you understand that this question is asking for only domestic sales and revenue?
- Please consider the phrase "Include sales and operating revenues to foreign customers, including foreign subsidiaries," Does that help you understand that this question is asking for only domestic sales and revenue?

Research and Development Module

R&D Activities

- Did all of the response categories make sense to you? If not, which categories did you experience difficulty with and why?

R&D Costs

- How did you come up with your response?
- Were the directions clear on what to include and not to include?
- In what dollar unit did you report?
- *If respondent has costs for R&D undertaken outside of the U.S., ask the following questions:*

- Did the respondent include any foreign R&D expenses in this question?
  - If yes, can the respondent split out the foreign vs. domestic R&D expense?
  - If no, what is the reason the foreign R&D expense was not included?
- Does your business' foreign R&D expenses include any of the following:
  - Salaries, wages, fringe benefits
  - Plant, machinery, and equipment, except that which was capitalized because it had an alternative future use Materials, supplies, software
  - Rent, utilities
  - Consultants, contractors
  - Depreciation expense from plant, machinery, and equipment that was capitalized because it had an alternative future use

<u>Types of R&D Costs</u>

- How did you determine your response for each option?
- Do you need to check records?
- Do you prefer providing percentages or dollar amounts?
- Does the request for percentages or dollar amounts impact how the respondent prepares their response?
- *Note if R provides a percentage and R's numbers don't add up to 100 percent. If so, probe as to why.*

<u>Funding Sources for R&D Activities</u>

- How did you determine your response for each option?
- Did you need to check records?
- Do you prefer providing percentages or dollar amounts?
- Does the request for percentages or dollar amounts impact how the respondent prepares their response?
- *Note if R provides a percentage and R's numbers don't add up to 100 percent. If so, probe as to why*

<u>Percent Paid For R&D Conducted by Others</u>

- How did you determine your response for each option?
- Did you need to check records?
- Do you prefer providing percentages or dollar amounts?
- Does the request for percentages or dollar amounts impact how the respondent prepares their response?
- *Note if R reports a percentage and R's numbers don't add up to 100 percent. If so, probe as to why.*

<u>R&D Categories</u> (*to be answered in dollar amounts instead of percentages)

- How did you determine your response for each option?
- Do you need to check records?
- Do you prefer providing percentages or dollar amounts?
- Does the request for percentages or dollar amounts impact how the respondent prepares their response?
- In what dollar unit did you report?

BUSINESS SALES

- What do you think this question is asking about?
- How did you come up with your answers?
- Did you experience any confusion when answering this question? If so, what could we do to improve how we are asking about this item?
- Do you have any suggestions on how we could ask these questions in order to make them easier for you to answer?

R&D Employees

- What do you think this question is asking about?
- How did you come up with your response?
- Did you experience any confusion when answering this question? If so, what could we do to improve how we are asking about this item?
- What time period did you have in mind when answering this question?
- Do you have any suggestions on how we could ask these questions in order to make them easier for you to answer?

R&D Employee Occupations

- What do you think this question is asking about?
- How did you come up with your response?
- Did you experience any confusion when answering this question? If so, what could we do to improve how we are asking about this item?
- What time period did you have in mind when answering this question?
- Do you have any suggestions on how we could ask these questions in order to make them easier for you to answer?

Technology Module

Production Technology for Goods and Services

- Can you tell me a little more about how you answered this question?
- What time period were you referencing when answering this question?
- Did the response categories make sense to you?

    - In your own words, please define what the following mean to you:
        - Testing, but not in production or service
        - Low Use
        - Moderate Use
        - High Use
- In your own words, can please define what the following mean to you:
    - Artificial Intelligence
    - Cloud-based Computing Systems and Applications
    - Specialized Software
    - Robotics
    - Specialized Equipment
- (Show them definitions) Now that you see the definitions, can you tell me if there are any that didn't match your definition? Why?
- What are the types of artificial intelligence (AI) that you use or are familiar with? Are there examples of AI that are not provided in the definition that you would recommend adding? Does your company do R&D that applies artificial intelligence to a problem? Does your company do R&D that is intended to advance the state of artificial intelligence?
- What are the types of specialized software that you use at your company?
- In your own words, what is the difference between AI and specialized software?
- (If R marked Robotics) Tell me about the robotics that you have at your company.
- What does the phrase "carrying out a complex set of actions" mean to you?
- What are the types of specialized equipment that you have at your company? Tell me about them. Are there any examples of specialized equipment that aren't listed that you would recommend that we add?
- In your own words, what is the difference between robotics and specialized equipment?

Motivation for Technology Adoption and Utilization (Process and Methods)

- What time period were you referencing when answering this question?
- Did the response categories make sense to you?
- Can you tell me a little more about how you answered this question for each of the categories listed?
- Are there other reasons why you used the technologies in this question other than the ones listed?

Impact of Technology on Workforce (Process and Methods)

- A. How did you decide on a response?
- B. How did you come up with your answer?
- (If R marked yes for Q3-B) How did the skill level of your workers change?

Impact of Technology on Worker Types (Process and Methods)

- A. How did you chose an answer for this question? What do you think is meant by the term “production workers?”
- B. How did you come up with your answer for this question? What types of workers did you think about when thinking about “non-production workers?”
- C. How did you come up with your response?
- D. What were you thinking about when answering this question?
- E. What do you think is meant by “skilled workers?” How did you come up with your response?

Technology Based Goods and Services

- How did you decide on a response?
- How did you come up with your answer?

Motivation for Technology Adoption and Utilization (Goods and Services)

- What time period were you referencing when answering this question?
- Did the response categories make sense to you?
- Can you tell me a little more about how you answered this question for each of the categories listed?

Impact of Technology on Workforce (Goods and Services)

- A. How did you decide on a response?
- B. How did you come up with your answer?

Impact of Technology on Worker Types (Goods and Services)

- A. How did you choose an answer for this question? What do you think is meant by the term “production workers?”
- B. How did you come up with your answer for this question? What types of workers did you think about when thinking about “non-production workers?”
- C. How did you come up with your response?
- D. What were you thinking about when answering this question?
- E. What do you think is meant by “skilled workers?” How did you come up with your response?

Factors Adversely Affecting Technology Adoption and Utilization

- What is this question asking about?
- How did you come up with your answers?
- *Probe R about each of the column headers.*

Wrap-up

For businesses with a proxy respondent during the interview:

- Now that you have seen this survey, would you typically be the one who would be responsible for answering this survey?
- *If so*, would you involve the owner(s) in answering these questions? Which questions?
- How would you go about asking the owner(s) to answer these questions? Would you provide them with a copy of the question/survey?
- Would you have the owner(s) review the completed form before it was submitted?
- Would you have any concerns or hesitancy about answering any of the questions about the owners without their input?

All businesses:

- Are there any other comments or suggestions you would like to make about anything we have gone over today?

Debriefing Questions

- What were your thoughts on completing the 2017 Annual Business Survey?
- About how long did it take you to complete the survey? Were others involved in completing the survey? If yes, was their time included in your estimate?
- How many owners are there at the company?
    - (if more than 1) How did you go about completing the question for the other owners? Did they review the questions and provide answers? What was your process for doing this?
- The survey asked questions about Research and Development activities. Did you have any issues answering questions in this section?
- Was there anything on the survey that stood out to you as difficult to answer or confusing?
- Do you have any recommendations for improving the survey?

Thank the respondent for their time.

Appendix C: 2019 Annual Business Survey (ABS) Questions

2019 Annual Business Survey

Company Information

1. **BUSINESS - 10% or MORE OWNERSHIP** In 2017, did at least one person own 10% or more of this business? (Do not count parent companies, estates, trusts or other entities.)

☐ Yes
☐ No - *Select "No" **ONLY** if no person owned 10% or more of this business.*

2. **NUMBER OF OWNERS**

For the pay period including March 12, 2017, how many people owned this business?
•*Do not combine two or more owners to create one owner.*
•*Count spouses and partners as separate owners.*

☐ 1 person
☐ 2 people
☐ 3 people
☐ 4 people
☐ 5-10 people
☐ 11 or more people
☐ Don't know

3. **NUMBER OF PAID OWNERS** Of the owners reported in the 'NUMBER OF OWNERS' question, how many received a W-2 issued by this business for salary or wages? ***If none, report zero.***

_____

4. NUMBER OF EMPLOYEES For the pay period including March 12, 2017, how many people worked for this business, including those paid through grants? *Include both full-time and part-time workers as well as yourself.* ***Count each person only once. If none, report zero.***

Non-Owners Number of People

a. Employees who received a W-2 issued by this business for salary or wages _____

b. Individuals who received payment in other ways
(for example, contractors/ consultants/temporary workers
who received a 1099 or payment from another business) _____

c. Unpaid individuals who worked for the business
(for example, interns, friends, family members) _____

5. TOTAL SALES AND REVENUES

What was the amount of this business's sales and revenues, including grants, during 2017? ***Report dollar amount in thousands. If none, report zero.***

$Bil. Mil. Thou.

2017 sales, revenues, and grants _____,000

6. DOMESTIC SALES AND REVENUES

How much of the 'TOTAL SALES AND REVENUES' in 2017 sales, revenue, and grants was attributable to or originated from domestic operations? Include sales and operating revenues to foreign customers, including foreign subsidiaries. For example, a U.S. manufacturing corporation sells parts to customers around the world, however, because all of its operations are located inside the United States it reports 100% of its sales in this question. ***Report dollar amount in thousands. If none, report zero.***

$Bil. Mil. Thou.

_____,000

Appendix D: Research and Development Module for 2019 ABS

Research and Development Module for 2019 ABS

1. R&D ACTIVITIES

During 2017, did this business do any of the following R&D activities? MARK ALL THAT APPLY

Include activities that:

- This business performed
- Others paid this business to do
- This business paid others to do

a. Conducted activities aimed at acquiring new knowledge or understanding without specific immediate commercial applications or uses ☐
b. Conducted activities aimed at acquiring new knowledge for solving a specific problem or meeting a specific commercial objective ☐
c. Conducted systematic work, drawing on research and practical experience and resulting in additional knowledge, which is directed to producing new products or processes or to improving existing products or processes ☐
d. Developed and tested goods, services, or processes that were derived from scientific research or technical findings ☐
e. Developed software that advanced scientific or technological knowledge ☐
f. Produced findings that could be published in academic journals or presented at scientific conferences ☐
g. Applied scientific or technical knowledge in a way that has never been done before ☐
h. Created new scientific or technical solutions that can be generalized to other situations ☐
i. Conducted work to discover previously unknown technological facts, structures, or relationships ☐
j. Conducted work to extend the understanding of scientific facts, relationships, or principles in ways that could be useful to others ☐

2. R&D COSTS

What was the total cost (both direct and indirect) in 2017 for all the R&D activities reported as "Yes" in the 'R&D ACTIVITIES' question? Your best estimate is acceptable.

Include the following costs:

- Salaries, wages, fringe benefits
- Plant, machinery, and equipment, except that which was capitalized because it had an alternative future use Materials, supplies, software
- Rent, utilities
- Consultants, contractors
- Depreciation expense from plant, machinery, and equipment that was capitalized because it had an alternative future use

Do not include:

- Costs for routine product testing, quality control, and technical services unless they are an integral part of an R&D project
- Market research
- Efficiency surveys or management studies
- Literary, artistic, or historical projects, such as films, music, or books and other publications
- Prospecting or exploration for natural resources

Total costs for 'R&D activities' reported in the R&D Activities question for 2017

$_____ 00

3. TYPES OF R&D COSTS

Of the total R&D amount reported in the 'R&D COSTS' question, what was the amount for the following types of costs?

a. Salaries, wages, and fringe benefits _____
b. Expensed machinery and equipment (not capitalized) _____
c. Materials and supplies _____
d. Payments to business partners for collaborative R&D _____
e. Purchased R&D services _____
f. Depreciation on R&D property and equipment _____
g. All other costs (for example, consultants, contractors, travel, rent) _____

4. FUNDING SOURCES FOR R&D ACTIVITIES:
Of the total R&D amount reported in the 'R&D COSTS' question, how much was paid for by the following sources?

a. This U.S. business _____
b. Your foreign owner (if the business is foreign owned) _____
c. Another U.S. business _____
d. Other businesses located outside the U.S. _____
e. U.S. university or college _____
f. U.S. non-profit organization _____
g. U.S. Federal government (including R&D grants) _____
h. U.S. State or Local government (not including state universities) _____
i. All other organizations outside the U.S. _____

5. PERCENT PAID FOR R&D CONDUCTED BY OTHERS:
Of the R&D amount this business paid others to perform, what amount went to another U.S. business, a U.S. university or college, or another source?

a. Another U.S. business _____
b. U.S. university or college _____
c. Other (specify) _____

6. R&D CATEGORIES:
Of the total R&D amount reported in the 'R&D COSTS' question, how much was for the following categories?

a. Basic Research – activities aimed at acquiring new knowledge or understanding without specific immediate commercial applications or uses _____

b. Applied Research – activities aimed at solving a specific problem or meeting a specific commercial objective _____

c. Development – systematic work, drawing on research and practical experience and resulting in additional knowledge, which is directed to producing new products or processes or to improving existing products or processes _____

7. R&D EMPLOYEES

For the pay period including March 12, 2017, how many employees from this business's foreign and domestic operations, were **R&D employees** and how many were **all other employees**?

R&D employees include all employees who work on R&D or who provide direct support to R&D, such as researchers, R&D managers, technicians, clerical staff, and others assigned to R&D groups. **Exclude** employees who provide only indirect support to R&D, such as corporate personnel, security guards, and cafeteria workers.

	(1)Domestic Operations	(2)Foreign Operations	(3)Total Employees
a. Female R&D employees	_____	_____	_____
b. Male R&D employees	_____	_____	_____
Total employees	_____	_____	_____
c. All other employees	_____	_____	_____
d. Total employees	_____	_____	_____

8. R&D EMPLOYEE OCCUPATIONS

For the pay period including March 12, 2017, how many of the total R&D Employees reported in the 'R&D EMPLOYEES' question worked in the occupations listed below?

	(1)Domestic Operations	(2)Foreign Operations	(3)Total Employees
a. Researchers (including R&D scientists, engineers, and their managers)	_____	_____	_____
Number of Researchers with PhD (excluding MD, JD, and EdD)	_____	_____	_____
b. R&D technicians and equivalent staff	_____	_____	_____
c. R&D support staff (clerical and other)	_____	_____	_____
d. Total R&D employees	_____	_____	_____

9. BUSINESS SALES

Please estimate the percentage of your business's total sales in 2018 from products (goods and services) that were, in the three years 2016 to 2018

	New or Improved Products		Unchanged Products (or with only minor changes)*		Total Sales in 2018
	--%	+		=	100%
If possible, separate sales from new or improved products between products	=				
Not previously offered by any of your competitors	--%				
	+				
Identical or very similar to products already offered by your competitors					

* Includes the resale of new products purchased from other enterprises.

Appendix E: Technology Module for 2019 ABS

TECHNOLOGY MODULE FOR 2019 ABS

(To be sent to all businesses and industries)

We provide both a short definition and detailed definition for each technology -- Short definition: Definition that appears near the question, and Detail definition: Definition that appears in pop-up or in detailed instructions.

Artificial Intelligence:

Short definition: Artificial intelligence is a branch of computer science and engineering devoted to making machines intelligent. Intelligence is that quality that enables an entity to perceive, analyze, determine response and act appropriately in its environment.

Detail definition: Artificial intelligence is a branch of computer science and engineering devoted to making machines intelligent. Intelligence is that quality that enables an entity to perceive, analyze, determine response and act appropriately in its environment. Systems with artificial intelligence perform functions including, but not limited to, speech recognition, machine vision, or machine learning:

- Speech recognition transforms human speech into a format useful for computer applications (for example, a digital assistant)
- Machine vision uses sensors and software that allow images to be used as an input for computer applications (for example, systems that sort or inspect objects or support navigation in mobile equipment)
- Machine learning uses statistical software and data to "learn" and make better predictions without reprogramming (for example, recommender systems for websites, or sales and demand forecasting)

Artificial Intelligence technologies also include virtual agents, deep learning platforms, decision management systems, biometrics, text analytics, and natural language generation and processing.

Cloud-based Computing Systems and Applications

Short definition: Cloud systems and applications are computing resources available on-demand via the internet.

Detail definition: Cloud systems and applications are computing resources available on-demand via the internet. Cloud computing enables ubiquitous, convenient, on-demand internet access to a shared pool of configurable computing resources (e.g., networks,

servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Specialized Software (excluding Artificial Intelligence):

Short definition: Specialized software is software dedicated to performing a particular business function.

Detail definition: Specialized software is custom or packaged software dedicated to performing a particular business function. Specialized software includes, but is not limited to, software applications for accounting, sales, marketing, customer service and billing, logistics, health care delivery, telemedicine, computer-aided design (CAD), computer-aided engineering (CAE), or inventory management. Specialized software excludes general purpose software such as word processing or spreadsheets. Exclude Artificial Intelligence software reported above.

Robotics:

Short definition: Robotic equipment (or robots) are automatically controlled, reprogrammable, and multipurpose machines used in automated operations in industrial and service environments.

Detail definition: Robotic equipment (or robots) are automatically controlled, reprogrammable, and multipurpose machines used in automated operations in industrial and service environments. Robots may be mobile, incorporated into stand-alone stations, or integrated into a production line. A robot may be part of a manufacturing cell or incorporated into another piece of equipment.

Industrial robots may perform operations such as: palletizing, pick and place, machine tending, material handling, dispensing, welding, packing/repacking, and cleanroom.

Service robots are commonly used in businesses for such operations as cleaning, delivery, construction, inspection, and medical services such as dispensing or surgery.

Specialized Equipment (excluding Robotics):

Short definition: Specialized equipment is equipment capable of automatically carrying out pre-specified task(s).

Detail definition: Specialized equipment refers to equipment capable of automatically carrying out pre-specified task(s). Specialized equipment includes, but is not limited to, computer numerically controlled (CNC) machinery, computer-aided manufacturing (CAM) systems, manufacturing cells, materials working lasers, automated guided vehicles systems, automated storage and retrieval systems, and automated materials handling systems. Exclude robotics equipment reported above.

Q1. Production Technology for Goods and Services

During the three years 2016 to 2018, to what extent did this business use the following technologies in producing goods or providing services?

Mark one for each row.

	Did not use	Testing, but not using in production or service	Low Use	Moderate Use	High Use	Don't know
Artificial Intelligence						
Cloud-based Computing Systems and Applications						
Specialized Software						
Robotics						
Specialized Equipment						

SKIP PATTERN

If all answers to Q1 are "Did not use", "Testing", or "Don't know" then proceed to Q5.

As before, if a respondent answers that a technology was used (low, moderate, or high), Q2-Q4 follow for each technology used.

Q2: Motivation for Technology Adoption and Utilization (Processes and Methods)

For each of the technology categories, please indicate whether any of the following was a reason for technology adoption and utilization during the three years 2016 to 2018.

Check all that apply for each row.

	Automate tasks performed by labor	Upgrade outdated processes or methods	Improve quality or reliability of processes or methods	Expand the range of goods or services	Adopt standards and accreditation	Other	Did not use
Artificial Intelligence							
Cloud-based Computing Systems and Applications							
Specialized Software							
Robotics							
Specialized Equipment							

Q3: Impact of Technology on Workforce (Processes and Methods)

For **{each of the above technology categories checked}**, please indicate whether this technology helped reorganize your workforce during the three years 2016 to 2018.

A. Did the technology allow your business to change its **number of workers**?
Mark one.

- Yes, we increased the number of workers
- Yes, we decreased the number of workers
- No, we did not change the number of workers

B. Did the technology impact the **skill level of workers**?
Mark one.

- Yes, worker skills increased overall
- Yes, worker skills decreased overall
- No, worker skills did not change overall

Q4: Impact of Technology on Worker Types (Processes and Methods)

For **{each of the above technology categories checked}**, please indicate whether this technology had an impact on the types of workers during the three years 2016 to 2018.

A. Did the technology impact the **number of production workers** employed by your business?
Mark one.

- We increased the number of production workers
- We decreased the number of production workers
- We did not change the number of production workers
- Not applicable, we did not employ production workers

B. Did the technology impact the **number of non-production workers** employed by your business?
Mark one.

- We increased the number of non-production workers
- We decreased the number of non-production workers
- We did not change the number of non-production workers
- Not applicable, we did not employ non-production workers

C. Did the technology impact the **number of supervisory workers** employed by your business?
Mark one.

- We increased the number of supervisory workers
- We decreased the number of supervisory workers
- We did not change the number of supervisory workers
- Not applicable, we did not employ supervisory workers

D. Did the technology impact the **number of non-supervisory workers** employed by your business?
Mark one.

- We increased the number of non-supervisory workers
- We decreased the number of non-supervisory workers
- We did not change the number of non-supervisory workers
- Not applicable, we did not employ non-supervisory workers

E. Did the technology impact the **types of skilled workers** employed by your business?

Mark one.

- Yes, worker scientific, technological, engineering and mathematical skills increased overall
- Yes, worker scientific, technological, engineering and mathematical skills decreased overall
- No, worker scientific, technological, engineering and mathematical skills did not change overall
- Not applicable, we did not employ workers with scientific, technological, engineering and mathematical skills

Q5. Technology-Based Goods and Services

During the three years 2016 to 2018, did this business sell the technology, or goods or services that included or embedded the technology?

Mark one for each row.

	Yes	No	Don't know
Artificial Intelligence			
Cloud-based Computing Systems and Applications			
Specialized Software			
Robotics			
Specialized Equipment			

SKIP PATTERN

If all answers to Q5 are "No" or "Don't know" then proceed to Q9.

If a respondent answers that a good or service was produced that included/embedded the technology, Q6 – Q8 follow for each embedded technology.

Q6: Motivation for Technology Adoption and Utilization (Goods and Services)

For each of the technology categories, please indicate whether any of the following was a reason for your business to produce the technology, or produce goods or services that included or embedded the technology, during the three years 2016 to 2018.

Check all that apply for each row.

	Upgrade goods or services	Expand the range of goods or services	Enter new markets or adapt existing products to new markets	Increase or maintain market share	Adopt standards and accreditation	Other	Did not produce
Artificial Intelligence							
Cloud-based Computing Systems and Applications							
Specialized Software							
Robotics							
Specialized Equipment							

Q7: Impact of Technology on Workforce (Goods and Services)

For **{each of the above technology categories checked}**, please indicate whether producing this technology, or goods or services that included or embedded this technology, led you to reorganize your workforce during the three years 2016 to 2018.

A. Did producing the technology or goods or services that included or embedded this technology lead your business to change its **number of workers**?

Mark one.

- Yes, we increased the number of workers
- Yes, we decreased the number of workers
- No, we did not change the number of workers

B. Did producing the technology or goods or services that included or embedded this technology impact the **skill level of workers**?

Mark one.

- Yes, worker skills increased overall
- Yes, worker skills decreased overall
- No, worker skills did not change overall

Q8: Impact of Technology on Worker Types (Goods and Services)

For **{each of the above technology categories checked}**, please indicate whether producing this technology, or goods or services that included or embedded this technology, had an impact on the types of workers during the three years 2016 to 2018.

A. Did the technology impact the **number of production workers** employed by your business?
Mark one.

- We increased the number of production workers
- We decreased the number of production workers
- We did not change the number of production workers
- Not applicable, we did not employ production workers

B. Did the technology impact the **number of non-production workers** employed by your business?
Mark one.

- We increased the number of non-production workers
- We decreased the number of non-production workers
- We did not change the number of non-production workers
- Not applicable, we did not employ non-production workers

C. Did the technology impact the **number of supervisory workers** employed by your business?
Mark one.

- We increased the number of supervisory workers
- We decreased the number of supervisory workers
- We did not change the number of supervisory workers
- Not applicable, we did not employ supervisory workers

D. Did the technology impact the **number of non-supervisory workers** employed by your business?
Mark one.

- We increased the number of non-supervisory workers
- We decreased the number of non-supervisory workers
- We did not change the number of non-supervisory workers
- Not applicable, we did not employ non-supervisory workers

E. Did the technology impact the **types of skilled workers** employed by your business?
Mark one.

- Yes, worker scientific, technological, engineering and mathematical skills increased overall
- Yes, worker scientific, technological, engineering and mathematical skills decreased overall
- No, worker scientific, technological, engineering and mathematical skills did not change overall
- Not applicable, we did not employ workers with scientific, technological, engineering and mathematical skills

Q9: Factors Adversely Affecting Technology Adoption and Utilization

For each technology, please indicate whether any of the following factors adversely affected the adoption or utilization of the technology during the three years 2016 to 2018.

Check all that apply for each row.

	Cost of technology	Maturity of technology	Access and reliability of required data	Access to required human capital and talent	Laws and regulations	Concerns regarding safety and security (physical and IP)	Other	None
Artificial Intelligence								
Cloud-based Computing Systems and Applications								
Specialized Software								
Robotics								
Specialized Equipment								

Appendix (Additional Definitions):

Production worker: A worker (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial and guard services, product development, auxiliary production for the own use of business (e.g. a power plant), recordkeeping, and other services closely associated with these production operations in the business covered by the report. Employees above the working-supervisor level are excluded.

Non-production worker: A worker engaged in the following activities: factory supervision above the working foreman level, sales (including driver-salesman), sales delivery (highway truck drivers and their helpers), advertising, credit collection, installation and servicing of own products, clerical and routine office functions, executive, purchasing, financing, legal, professional, and technical. Also included are employees on the payroll of the business engaged in the construction of major additions or alterations to the plant who are utilized as a separate work force.

Supervisory worker: A worker whose major responsibility is to supervise, plan, or direct the work of others, such as top executive and managerial positions, officers of corporations, department heads, and superintendents.

Non-supervisory worker: A worker who does not supervise, plan, or direct the work of others.