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IMPROVING THE TRACKING AND TRACEABILITY OF U.S. FOOD AID: A FEASIBILITY STUDY

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FINAL REPORT

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DISCLAIMER

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ACRONYMS

AIDC	-	Automatic Identification and Data Capture
API	-	Application Programming Interface
BHA	-	Bureau of Humanitarian Assistance
CBA	-	Cost-Benefit Analysis
CBO	-	Country Backstop Officer
EDI	-	Electronic Data Interface
EFSP	-	Emergency food security program
ERP	-	Electronic Resource Planning
FFP	-	Food for Peace
FY	-	Financial Year
GAO	-	Government Accountability Office
HIMS	-	Humanitarian Inventory Management System
ID	-	One-Dimensional
IO	-	Implementing Organization
IP	-	Implementing Partner
IT	-	Information Technology
KCCO	-	Kansas City Commodity Office
KG	-	Kilogram
LRP	-	Local or regional purchase
M&E	-	Monitoring and Evaluation
MIT LL	-	Massachusetts Institute of Technology Lincoln Laboratory
MT	-	Metric ton
MVP	-	Minimum Viable Product
NGO	-	Non-governmental Organization
NPV	-	Net Present Value
OFDA	-	Office of Foreign Disaster Assistance
PIO	-	Public International Organization
PO	-	Purchase Order
PP	-	Polypropylene
PREPO	-	USAID prepositioning warehouses
PVO	-	Private Volunteer Organization

QR Code	-	Quick Response Code
RFID	-	Radio Frequency Identification
RUSF	-	Ready-to-Use Supplementary Food
RUTF	-	Ready-to-Use Therapeutic Food
S&H	-	Shipping and Handling
SAP	-	"Systems, Applications & Products in Data Processing" (Company)
UN	-	United Nations
URL	-	Uniform Resource Locator
USAID	-	United States Agency for International Development
USD	-	United States dollar
USDA	-	United States Department of Agriculture
USG	-	United States Government
WBSCM	-	Web-based supply chain management
WFP	-	World Food Programme
WVI	-	World Vision International
XML	-	Extensible Markup Language

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EXECUTIVE SUMMARY

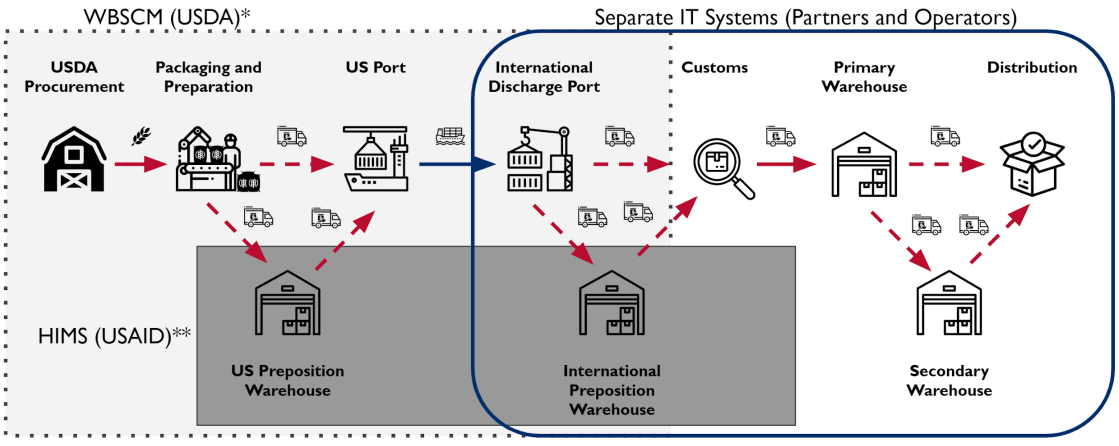
INTRODUCTION

The United States Agency for International Development (USAID) Bureau for Humanitarian Assistance (BHA) plays a lead role in efforts to provide humanitarian assistance to the world's most vulnerable and hardest-to-reach people. USAID/BHA provides food commodities grown by American farmers when partner country food supplies are limited or inaccessible. In fiscal year (FY) 2019, these U.S.-sourced products accounted for approximately 41 percent of USAID's $4.38 billion food assistance budget and over 1.7 metric tons (MT) of food.

The process starts when qualifying public international organizations (PIOs) and private voluntary organizations (PVOs) make food requests to the U.S. Government. If approved, the commodities are sent from suppliers to transport points or warehouse facilities at various logistical nodes of the supply chain, including U.S. ports, foreign discharge ports, and U.S. and international USAID prepositioning warehouses (PREPOs). At some point in the process, the food commodities are transferred to partner organizations, who are then responsible for distributing the food commodities using their own transport and distribution partner networks and their own information tracking systems.

As U.S.-sourced commodities move along the supply chain, stakeholders use their own information technology (IT) systems for sending, validating, and reconciling food aid deliveries. In many instances, data is shared in paper form, spreadsheet, or email. The result is a supply chain structure in which fragmented information flows impede the full potential of effectively managing and tracking food aid commodities. The use of disparate systems also presents challenges with tracing food commodities when there are recalls or food quality issues. For instance, there can be substantial time lags when independent systems are used to trace the origin of a commodity. This can result in high administrative costs and the expiration of food that was incorrectly included in the initial recall.

Figure 1: Existing U.S.-Sourced Food Commodity Supply Chain



** WBSCM = Web-Based Supply Chain Management*
*** HIMS = Humanitarian Information Management System*

Source: Author's representation.

This study aimed to assess the technical and economic feasibility of introducing an integrated IT solution to allow for semi-automatic and easier tracking and tracing of commodities across the supply chain. Given the large scale of transportation and warehousing of food commodities, the team started with the assumption that even a minor efficiency gain can lead to significant savings. Therefore, the team has picked a conservative methodology in which a defensible subset of benefits of transitioning to an integrated IT solution is compared with the upper bound estimates for its costs. This approach helps in building a strong policy argument, should the lower bound of benefits exceed the upper bound of costs when assessing the feasibility of transitioning into the new system.

PROPOSED IT SOLUTIONS

USAID/BHA aims to improve the accuracy and accountability of the U.S. food aid supply chain by reducing the time and potential errors associated with manual data entry. It also wants to enhance USAID/BHA's monitoring and evaluation system to improve food aid management, beneficiary targeting, and product traceability. Lastly, USAID/BHA wants to address long-standing issues with commodities, such as the source of infestations, damages, and theft. To achieve these goals, USAID is considering several IT investments that could lead to the uniform collection and sharing of food aid data, including an Automatic Identification and Data Capture (AIDC) system that uses Quick Response (QR) codes.

An AIDC system refers to methods used to identify objects automatically, collect data about them, and enter this information into a computer system.[1] This system, which does not require direct human involvement, makes data collection efficient and consistent and removes much of the capacity for human error. USAID/BHA envisions a system of comprehensive data collection for the purposes of tracking and tracing food aid flows that heavily incorporates AIDC at key points in the supply chain. This system will allow users to see if commodities are lost in transit between key nodes or determine if the commodities in storage are at risk of expiring.

Created in the 1990s, QR codes are two-dimensional barcodes that can efficiently hold data in a compact format and can be read instantly by scanners or mobile phones, even if partially damaged or warped. Based on discussions with USAID and secondary research, the team is considering the use of QR codes over several other technologies due to issues of affordability, availability, and the amount of information that can be stored on a QR code. Specifically, QR codes provide more information than a barcode, yet the implementation costs are similar. In addition, the underlying infrastructure required to operate an alternative technology like radio frequency identification (RFID) is costly and unavailable in many countries.

STUDY PURPOSE AND APPROACH

USAID/BHA's Office of Field and Response Operation requested that the USAID-funded Learning, Evaluation, and Analysis Project (LEAP III) team conduct a feasibility study to provide decision-makers with a thorough understanding of the investments, procedures, and incremental costs and benefits of implementing the proposed IT solutions across the U.S. food aid supply chain. The study is also supposed

[1] AIDC systems include a variety of technologies, such as QR codes, bar codes, radio frequency identification (RFID), and biometrics, among others. See Wikipedia, 2020 for a full list of technologies (available at https://en.wikipedia.org/wiki/Automatic_identification_and_data_capture).

to give insights as to how the enhanced data visibility provided by these IT solutions could affect the management and governance of food aid in terms of improved accountability, planning, and reporting.

The team has worked extensively with BHA to develop a comprehensive approach for carrying out an analysis that assesses the feasibility and potential impact of implementing the new IT supply chain management solutions. This approach is guided by three analytical components:

- **Technical Feasibility** — The feasibility of the USAID's investment will depend on the functionality of available technology.

- **Operational Feasibility** — The introduction of a new IT system in a large organization like BHA, and its rollout through a supply chain with many partner organizations is complex and subject to many barriers. Therefore, the overall feasibility of this investment depends on the strategy and implementation plan to roll out the IT solutions. The team has provided recommendations for how USAID can use a gradual and iterative approach for implementing the solutions across its commodities.

- **Economic Feasibility** — An economic cost-benefit model is used to compare the estimated costs and benefits of changing from the status quo to the proposed IT solutions. For the economic analysis to result in a strong policy argument, the team has taken a conservative approach and compared a defensible sunset of benefits with an upper bound for costs.

RESULTS AND CONCLUSIONS

ECONOMIC ARGUMENT FOR INVESTING IN THE IT SOLUTIONS

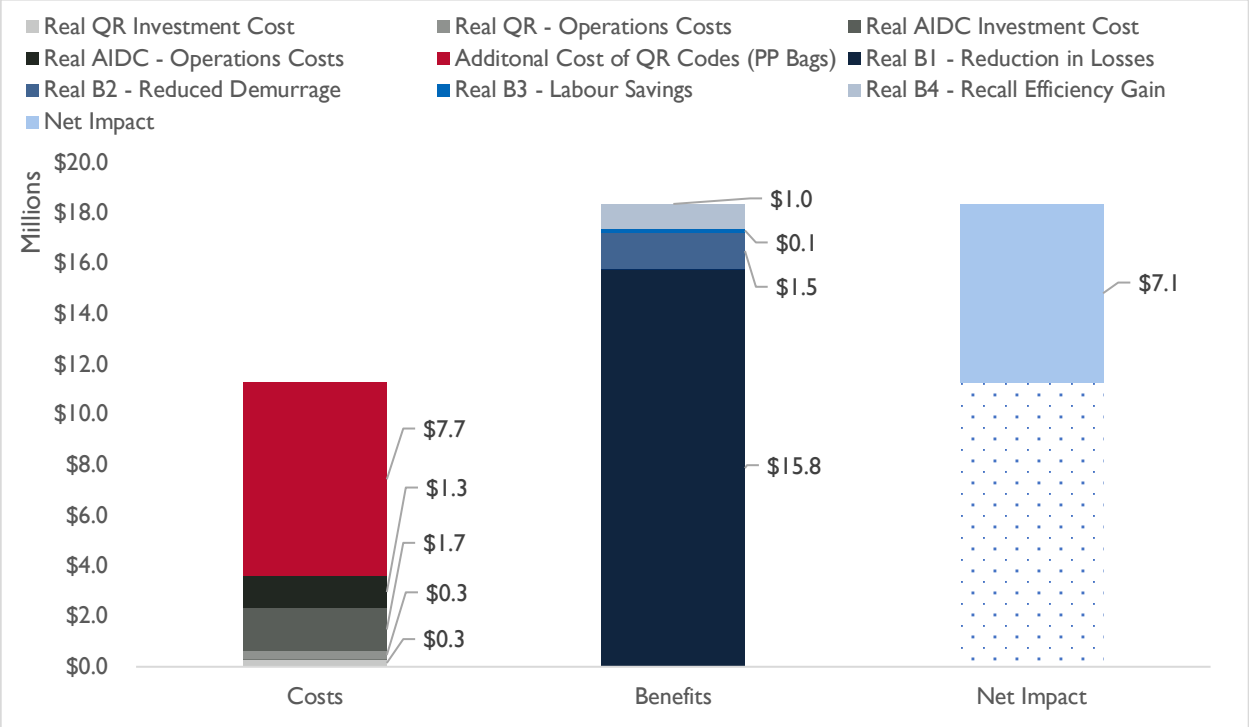
There is a strong economic argument for investment in tracking and tracing. The team met with numerous stakeholders from around the world and discussed the costs inherent in the current way food aid is tracked and traced. The lack of clarity on the current volume of food lost in the supply chain is evident to the issues that arise when an IT solution is not in place. Through surveys and interviews with different segments of the supply chain, the team has estimated that roughly 2 percent of food is lost in the supply chain each year. The respondents also indicated that about 30 percent (0.58 percentage points) of these losses could be avoided, should an AIDC system become operational. The potential savings discounted over 15 years is roughly equal to 13,400 MT of food, which is equivalent to 67,080 people being fed for 12 months. At an average landed cost of $528 dollars per ton, this translates to a net present value of approximately 7.1 Million USD over the next 15 years.[2]

On the cost side, the team estimates that an initial investment cost of $2 million and an annual maintenance cost of $350,000 should be more than sufficient to cover the scope of the project to include the printing of QR codes and the establishment of an AIDC system. Given the uncertainties associated with setting up this type of system across the entire food aid supply chain, the team has used a highly conservative estimate for the annual maintenance costs, In practice, these costs decline over time. Even when using these conservative assumptions, this investment has a net present value of $7,089,563, an internal rate of

[2] See Section 5.2, CBA Outputs, and Annex V, Cost-Benefit Model, for calculations.

return of 32 percent, and a payback period of roughly six years. The main sources of costs and benefits and the investment criteria are summarized in the figure below.

Figure 2: Sources of Costs and Benefits and the Investment Criteria



Source: Author's representation

There remain two sources of risk for this investment. The first is the potential for the AIDC system to be delayed or fail to enter operations, which could happen for several reasons, including a lack of stakeholder support. Secondly, small changes in the marginal costs of commodity packaging could be costly when extended to the entire supply chain. Even a marginal cost of five cents per bag would have a significant impact on the economic viability of this investment. Based on conversations with multiple stakeholders, the team expects any increase in the marginal cost of packaging to be primarily associated with the increased cost of getting QR codes print on woven PP bags.

SUPPLY CHAIN STAKEHOLDERS USE DISPARATE DATA MANAGEMENT SYSTEMS

A significant number of stakeholders use spreadsheets and paper forms to monitor food aid inventories and to track U.S. food aid shipments and distributions. According to feedback from the 2020 Survey of Food Aid, partner organizations primarily use spreadsheets, paper forms, and electronic forms to monitor food aid commodity inventories, shipments, and food aid distributions. Similarly, warehouse operators report using spreadsheets and commercial software to monitor food aid shipments and warehouse inventories, whereas the most common methods for reporting food aid flows to stakeholders (e.g., USAID, PVOs, PIOs, etc.) are by email and spreadsheets.

THERE IS A SOLID FOUNDATION FOR IMPLEMENTING THE IT SOLUTIONS

USAID and its partners are clearly aware of the benefits of improving the data visibility of food commodities, which is demonstrated by completed, existing, and planned QR code and AIDC pilots and initiatives.[3] The completed pilots have provided valuable feedback regarding the existing capacity and costs to print and scan QR codes. Specifically, the pilots have demonstrated that suppliers have the capacity to add QR codes, and the marginal costs are low for the piloted packaging types. However, staff at the distribution points need adequate training to properly scan and use the QR codes. Ongoing and planned pilots are significantly more complex and will provide powerful insights for constructing the AIDC system and processes for scaling technologies.

Supply chain stakeholders have built strong foundations to implement pilots and coordinate common technical solutions. USAID/BHA is currently involved in several working groups responsible for coordinating pilots and establishing common procedures and protocols for adding QR codes to food aid packaging. USAID/BHA is also engaged in international packaging conferences and workshops, such as the 2020 Food Aid Packaging Workshop.

PACKAGING REQUIREMENTS AND LEADERSHIP INVOLVEMENT

Although it is possible to add QR codes on most food aid packaging types with limited modifications or investments, it is not yet possible to consistently use QR codes on the existing packaging design for woven polypropylene (PP) bags. Investments and adjustments are needed to add and use QR codes on food aid commodities like palletized vegetable oil, ready-to-use supplementary food (RUSF) and ready-to-use therapeutic food (RUTF) packages, and commodities in hybrid paper bags. However, the existing material used on PP bags does not consistently retain the QR code as it moves across the supply chain, meaning it is not always possible to scan PP bags once they reach partner countries. A potential alternative may be to use QR codes only at the batch or lot level. Another potential solution would be to investigate the use of new packaging procedures and/or materials

Although officials at USAID and partner organizations are actively leading the effort to coordinate pilots and establish the foundation for adopting the IT solutions, senior leaders from each stakeholder organization are not yet promoting these technologies. With that said, USAID/BHA's Office of Field and Response Operations is building the business case for using these technologies, including pilots and this feasibility study, which will be communicated to senior leaders in the near future.

RECOMMENDATIONS

The team also has several recommendations as to the next steps for the design and implementation of these IT solutions. These recommendations are motivated by USAID/BHA's overall goal of transitioning

[3] USAID successfully completed a pilot to print and read QR codes on hybrid paper bags (25kg) containing wheat flour. Similarly, WFP piloted the Last Mile Solution in Ethiopia, involving the printing of QR codes on waybills and the creation of a dedicated mobile platform for electronic scanning and receipt confirmation. The Massachusetts Institute of Technology Lincoln Laboratory (MIT LL) has partnered with USAID to build an Intelligent Food Tracking System and Dashboard to add more data visibility to the supply chain, while MANA, a non-profit RUFT supplier, is leading a QR code pilot that provides product details, status updates, and real-time responses.

to a comprehensive system for accessing and sharing food aid data—from the time the commodity is packaged to the final distribution point where commodities are given to beneficiaries.

1. **USAID and other stakeholders will need to agree on a well-coordinated, holistic approach for rolling out new technologies, such as common IT requirements and realistic timelines for adoption.**

The expectations and timelines will differ based on the actor's role within the supply chain. USAID and USDA, for instance, will need to specify the appropriate reporting systems, lead times, and packaging requirements for printing and using QR codes in a common AIDC solution. Similarly, downstream supply chain actors, such as PVO transport and warehouse operators, will need to have the means, lead times, and systems for implementing the new solutions, including the financial resources to invest in the necessary IT data systems and scanning equipment.

2. **Stakeholders will need to use a gradual and iterative approach to shift from disparate data tracking systems to a common AIDC system. This can be achieved by implementing the IT solutions over three phases.**

The team believes this goal can be achieved by implementing the IT solutions over three phases, each with its own objectives and iterative processes. The first phase would involve the development of the project scope by a cross-functional team of supply chain stakeholders. The second phase would include the investments and systems needed to print, collect, and store QR codes. The final phase would involve the collective adoption of an AIDC system.

3. **The initiative will need the active support of senior leaders, such as division chiefs, directors, and administrators, to implement the IT solutions successfully.**

This will include the approval of financial resources and personnel to assist with the design and implementation of the respective IT systems. USAID senior officials will also need to engage proactively with senior officials at partner organizations to champion the initial use of an online database to maintain the QR code data and the eventual adoption of a common AIDC system. The team recommends that USAID leaders start with those organizations where strong relationships exist or where solid informational structures are present.

4. **USAID should implement QR codes (Phase II) over three cycles to provide ample time for identifying the packaging requirements and printing processes for adding QR codes to certain commodities.**

The first cycle should be directed toward a subset of food aid commodities and shipment types with the greatest potential for success, such as palletized vegetable oil, RUSF and RUTF packages, and commodities in hybrid paper bags. The second cycle should include the printing of QR codes on PP bags for prepackaged commodities. The third cycle would include the printing of QR codes on PP bags that accompany bulk shipments to discharge ports. It is especially important to pilot the PP woven bags, because they are used for the majority of the BHA food aid supply, and the success of this solution depends on figuring out how to print easily scanned QR codes at a minimal cost.

5. **USAID should use custom QR codes in its initial rollout for a limited set of food categories without any integration requirements or complexity.**

USAID currently has the option of using static, dynamic, or custom QR codes, Static QR codes are immutable and can be read without an Internet connection, whereas dynamic QR codes can be updated periodically but would require an Internet connection for real-time updates. Custom QR codes, which are a combination of these two types, would enable a quick, low-cost rollout for the initial phase. It is critical that the custom QR code design have a strong foundation so that the QR code can be enhanced in subsequent phases when the QR code is added to different food commodities. This additional functionality would also be critical when integrating existing IT solutions (e.g., USAID's Humanitarian Inventory Management System [HIMS]).

6. **USAID will need to work collaboratively with USDA, suppliers, and partner organizations to identify a packaging solution and process for commodities currently shipped and packaged in PP bags.**

Based on discussions with food aid packaging suppliers, it is difficult to print a QR code on a 50 kg PP bag due to the sheen of the existing packaging material. Some potential solutions include a half-laminated PP bag, smaller PP bags that will better hold and retain the QR code, or patching the QR code into the existing PP packaging type. Other barriers will need to be considered. For example, there are potential bagging solutions for bulk commodities packaged at the discharge port, but they cannot be used due to how the bags are sealed.

7. **USAID and partner organizations will need to develop a process for packing bulk commodities into PP bags containing the QR codes.**

Millions of PP bags accompany bulk shipments to the discharge ports where the commodities are matched and packaged in the appropriate PP bags. Therefore, it is theoretically possible to match the bulk commodity to the relevant QR code bag once a new PP packaging type has been designed. However, stakeholders feel that the existing processes do not always result in the proper packaging of bulk commodities, which would result in data integrity issues as commodities move along the supply chain.

8. **To implement an AIDC solution, all stakeholders will need to align under common goals and objectives, incorporate the IT business requirements of each actor, and develop a minimum viable product (MVP).**

USAID and stakeholders will need to build on the lessons learned, successes, and partnerships that are established with the implementation of QR codes (Phase II) to align on the common goals of an AIDC solution. USAID will also need to work with stakeholders to finalize the AIDC business requirements, which should specify how the AIDC solution would receive and share data with other systems like web-based supply chain management (WBSCM), HIMS, and the World Food Programme's (WFP's) SAP solution. USAID will also need to develop an MVP, the most useful and logically sound system that can be implemented with the lowest time and resource costs. The MVP will represent the solution that has the highest probability of adoption.

9. **To increase the likelihood of success, USAID officials with strong technical and leadership skills will need to lead the AIDC process.**

USAID staff should have expertise in the following areas: program and project management, solution design and data modeling, and techno-functional skills that cover both international supply chain and IT technical expertise. The team strongly recommends that members of the USAID/BHA team should be involved in leading this process.

10. **It is also critical that the AIDC solution design and implementation plan are socialized with stakeholders.**

USAID and key stakeholder organizations should hold focus group discussions, meetings, and workshops to give supply chain participants an opportunity to review the design and provide feedback. This would give stakeholders a sense of ownership over the solution and increase the chances that the centralized system meets the needs of all U.S. food aid supply chain actors. At this point in time, the team does not believe there is any off-the-shelf solution that address all of USAID's requirements. However, this might change when the overall solution requirements have been defined.

11. **Any rollout of the IT solutions should be combined with a robust training program customized for each stakeholder group.**

This will be particularly important for stakeholders who are further removed from a reliable IT network and may not have the information or training to scan, store, and access information tied to QR codes. USAID and partner organizations should set their budgets to accommodate the training and schedule them in accordance with the IT solution timelines. Given the current constraints of COVID-19, this training should be offered for both in-person and virtual attendance.

1. OVERVIEW AND BACKGROUND

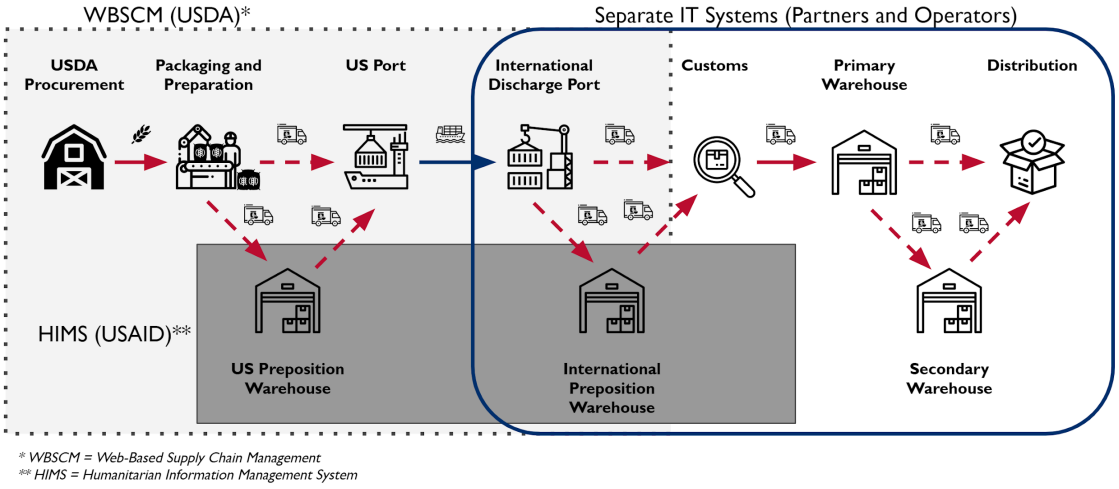
1.1 BACKGROUND

USAID/BHA plays a lead role in efforts to provide humanitarian assistance to the world's most vulnerable and hardest-to-reach people. Established in 2020, BHA comprises two former USAID offices—the Office of U.S. Foreign Disaster Assistance (OFDA) and FFP. The Bureau continues OFDA's work of leading and coordinating U.S. Government assistance for international disasters and builds on FFP's work of providing emergency food and development assistance to alleviate hunger and improve food security.

In FY 2019, FFP's portfolio included a total food assistance budget of $4.38 billion, which was used to deliver almost 2.5 million MT of food to beneficiaries in 55 countries. USAID/BHA food assistance is used for emergencies where local authorities lack the resources to address food shortages. This food assistance is delivered by partner organizations using four modalities: locally or regionally purchased food, U.S.-grown food, market-based food vouchers, and flexible market-based food vouchers, such as cash, mobile, or debit card transfers. When making a request for food assistance, USAID's partners recommend a modality based on several criteria, such as market conditions, feasibility (e.g., timeliness and security), and cost.

USAID provides food commodities grown by American farmers when local food supplies are limited or inaccessible. In FY 2019, these U.S. sourced commodities accounted for approximately 41 percent of FFP's food assistance budget and more than 1.7 MT of food. The process starts when qualifying PIOs and PVOs make food requests to USAID. If approved, the requests are sent to the U.S. Department of Agriculture (USDA) for review and approval. USDA then solicits contract bids and procures food commodities for approved requests, and USAID assists partner organizations with the procurement of ocean freight.

Figure 3: Existing U.S.-Sourced Food Commodity Supply Chain



Source: Author's representation

The commodities are then sent from suppliers to transport points or warehouse facilities at different logistical nodes of the supply chain, including U.S. ports, foreign discharge ports, and U.S. and international

USAID prepositioning warehouses (PREPO). At some point in the process, the food commodities are transferred to partner organizations, who are then responsible for distributing the food commodities using their own transport and distribution partner networks, as well as their own information tracking systems (see Figure 1 above).

As U.S.-sourced commodities move along the supply chain, stakeholders use their own IT systems for sending, validating, and reconciling food aid deliveries. The result is a supply chain structure in which fragmented information flows impede the full potential of effectively managing and tracking food aid commodities. The use of disparate systems also presents challenges with tracing food commodities when there are recalls or food quality issues. For instance, there can be substantial time lags as stakeholders use their respective systems to trace the origin of a food recall, which can result in unnecessary administrative costs and the expiration of food commodities that were incorrectly included in the initial recall.

USAID/BHA's aims to improve the accuracy and accountability of the U.S. food aid supply chain by reducing the time and potential errors associated with manual data entry; enhancing the monitoring and evaluation system to improve food aid management, beneficiary targeting, and product traceability; and by addressing longstanding issues with commodities, such as the source of infestations, damages, and theft. To achieve these objectives, USAID/BHA is considering the investment in IT solutions that will lead to the uniform collection and sharing of food aid data. These potential solutions include an end-to-end AIDC system and barcoding technologies like QR codes.

1.2 FEASIBILITY STUDY PURPOSE

> ***"Often, we know what was authorized in awards, but we don't have eyes on how much food has arrived at a specific geographic location. Greater real-time visibility on this should help better identify gaps and improve coordination."***
>
> ***- USAID Staff***

The goal of this feasibility study is to provide decision-makers with a thorough understanding of the investments, procedures, and incremental costs and benefits of implementing the QR code and AIDC solutions across BHA's supply chain for U.S. in-kind food assistance. The study will also give insights as to how the enhanced data visibility provided by these IT solutions could potentially affect the management and governance of U.S. food aid in terms of improved accountability, planning, and reporting. The team begins this study by describing the research methods that were used to conduct this analysis. The report then details the assessment of the technical, financial, and economic feasibility of implementing these IT solutions, including the inherent risks associated with each of these topics. The team then concludes the study with a series of recommendations for USAID and stakeholders to consider.

2. RESEARCH METHODS

The team has worked extensively with the BHA team to develop a comprehensive approach for carrying out an analysis that assesses the feasibility and potential impact of implementing a new IT supply chain management solution. Findings from this analysis provide decision-makers with a thorough understanding of the requirements, procedures, and incremental costs and benefits of adopting the IT solutions across the supply chain. Our approach is guided by three analytical components:

1. Technical feasibility
2. Operational feasibility
3. Economic feasibility

After providing a summary for each of these components, the team will describe the main qualitative and quantitative data that supports our study and recommendations.

TECHNICAL FEASIBILITY

The feasibility of the USAID's investment will depend on the functionality of available technology. Our team has researched the available options and determined their suitability for improving the tracking and traceability of food aid. Our research includes the required technical elements of the IT solutions to include barcodes, printers, scanners, and database solutions. Based on discussions with USAID, our team has narrowed the scope of potential technical solutions to QR codes and an AIDC system.

OPERATIONAL FEASIBILITY

The operational feasibility assesses the steps USAID has taken and will need to take to implement the IT solutions successfully. This assessment includes recommendations for how USAID can use a gradual and iterative approach for implementing the solutions across a broad spectrum of commodities. In addition, the team describes the necessary institutional factors, such as effective leadership, a customized training strategy, and strategic partnerships that are needed to operationalize the IT solutions effectively.

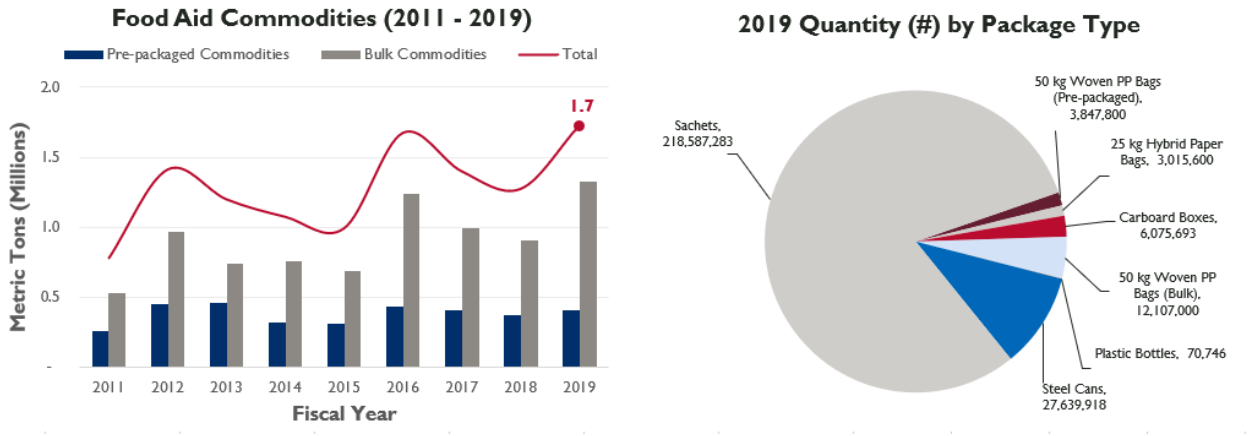
ECONOMIC FEASIBILITY

The team has constructed an economic cost-benefit model that compares the estimated costs and benefits of changing from the status quo to the proposed IT solutions. The model provides multiple economic decision criteria, such as the economic rate of return and net present value, to determine the circumstances under which the proposed solutions are feasible. The feasibility criteria have been calculated using a subset of benefits that is strongly defensible, to ensure a conservative, yet robust result. Our team has also analyzed the sensitivity of key model parameters to identify key risks and critical assumptions.

QUANTITATIVE AND QUALITATIVE DATA SOURCES

The team has spent a considerable amount of time learning about BHA's operations and on the way, has collected several primary qualitative and quantitative data sources to support our analysis and recommendations. The feasibility study uses quantitative data from several key sources, including BHA reports that provide snapshots of the scale and scope of its operations. These resources are used to source the volumes of commodities and packages procured and shipped each year (see Figure 2), and the associated prices with said procurements. The BHA team has also shared spreadsheets that track commodity procurements and shipping contracts. This information includes price and volume flow at key logistical nodes, which are used to estimate how much freight is moving at a time in the system.

Figure 4: U.S.-Sourced Food Aid by Packaging Type and Volume



Source: USDA Procurement Data (2011 - 2019); USAID Packaging Data (2019)

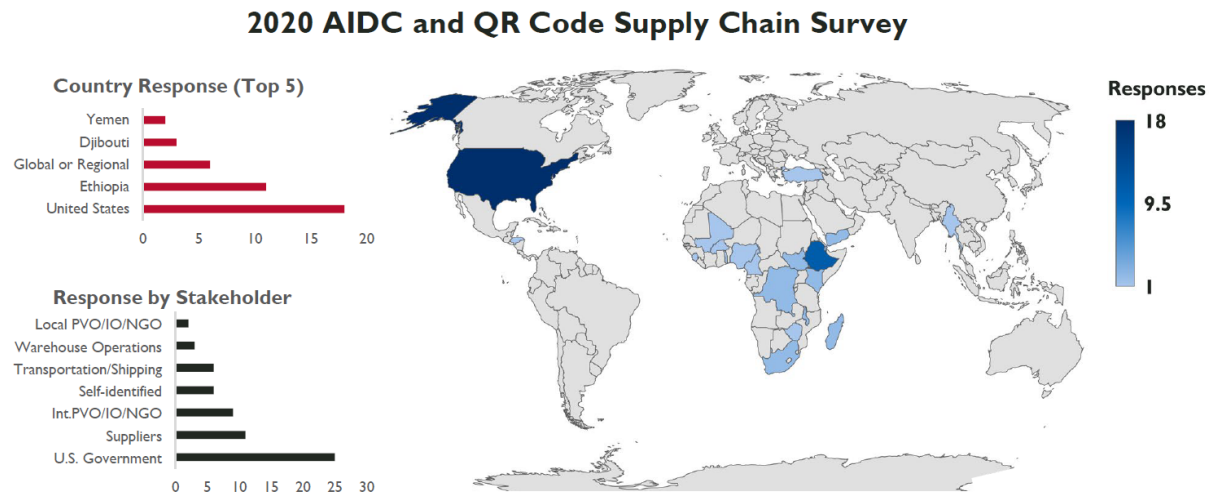
The team originally scheduled five field visits to meet with and ask questions of individuals who play key roles in the food aid supply chain. The planned U.S. field visits included Washington D.C., Houston, Texas; and Lansing, Michigan; and the international destinations involved site visits to the Djibouti port and various transportation, warehouse, and distribution sites in Ethiopia. After it became apparent that the COVID-19 pandemic would make international travel impossible, the team revised its research methodology to account for the lack of field visits to Ethiopia and Djibouti. Specifically, the team developed an online survey that was sent to food assistance supply chain stakeholders. Annex I provides a full list of interviewed stakeholders, and the following content describes the field visits and survey.

In January 2020, the team traveled to Washington D.C. to meet with USAID officials and other key stakeholders, to include freight forwarders, staff from the Government Accountability Office (GAO), and contractors who helped develop and manage the digital infrastructure that currently serves USDA and USAID. This was followed by a trip to Houston in February 2020 to meet with PREPO management and tour PREPO warehouse facilities. The team also met with packaging and commodity suppliers and toured manufacturing facilities to gain a better understanding of the technical and operational changes needed to add QR codes to food aid packaging. Finally, the team participated in the March 2020 Food Aid Packaging

Workshop at Michigan State University, where food aid supply chain stakeholders met for three days to discuss potential improvements to the tracking and tracing of food aid. The team presented initial findings and discussed the goals of the study with stakeholders from the BHA and USDA and stakeholders from the NGO and supplier communities. The team scheduled follow-up discussions with numerous stakeholders from the conference to understand better the potential roadblocks and key considerations for the successful rollout of the QR and AIDC solutions.

From June 2020 to August 2020, the team remotely gathered information from the United States and internationally based stakeholders by deploying short surveys to the following stakeholders—shipping and handling contractors; USAID/BHA partners (PVOs, PIOs, and service contractors), USAID/BHA personnel and other U.S. government representatives, and commodity and packaging suppliers. These short surveys included customized questions associated with each stakeholder's role in the supply chain. Figure 3 provides some general statistics for participation in our survey, including a strong representation from USG officials, suppliers, and international partners.

Figure 5: U.S.-Sourced Food Aid by Packaging Type and Volume



Source: 2020 Survey of Food Aid

3. TECHNICAL FEASIBILITY

The overall feasibility and success of this initiative depend on the design, functionality, and speed with which the technology is deployed. The team researched various available technology options and determined which options are suitable for designing a solution that can help overcome existing limitations and deliver improved data-driven insights, tracking, traceability, and improved control of the U.S. food aid supply chain.[4] The team discussed the technical and high-level design elements of the possible solutions with the MIT Lincoln lab team working on USAID/BHA's intelligent food tracking dashboard. The proposed IT solutions include different types of barcodes, printers, scanners, web-based development tools and database solutions.

The LEAP III team is recommending technology options that can help operationalize QR codes and subsequently, an AIDC solution, with the least amount of cost, effort, and resistance from supply chain stakeholders. These options also offer flexibility and scalability for future solutions and needs. The technical feasibility is divided into two sub-sections, one focusing on an AIDC solution and the other dealing with QR codes.

3.1 AUTOMATIC IDENTIFICATION AND DATA CAPTURE (AIDC)

"Automatic identification and data capture (AIDC) refers to the methods of automatically identifying objects, collecting data about them, and entering them directly into computer systems without human involvement. Technologies typically considered as part of AIDC include QR codes, bar codes, radio frequency identification (RFID), biometrics (like iris and facial recognition system), magnetic stripes, optical character recognition (OCR), smart cards, and voice recognition." [5]

An AIDC system makes data collection efficient, consistent, and removes much of the capacity for human error. Currently, the food aid supply chain is monitored by a variety of different data collection systems, each managed by a separate actor, and with distinct standards and analytical capacity inherent in their output. Although some portions of the supply chain use modern industry standards for real-time data visibility (e.g., electronic data interface [EDI] for international shipping), many portions of the food aid supply chain remain shrouded in mystery (especially warehousing and distribution beyond the discharge port). For decision-makers, obtaining a full picture of the supply chain, with clarity around bottlenecks, will be an invaluable asset going forward.

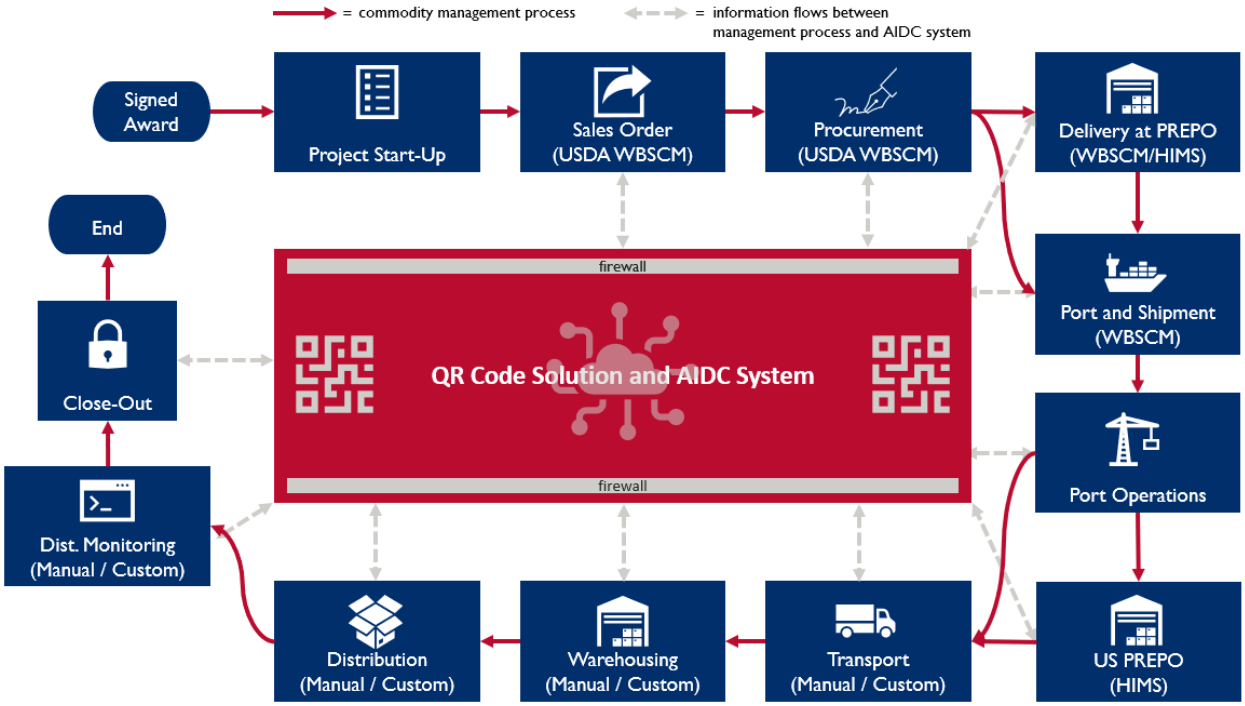
Based on discussions with Agency officials, USAID envisions a system of comprehensive data collection for the purposes of tracking and tracing food aid flows that heavily incorporates AIDC at key points in the supply chains. This system will allow users to see if commodities are lost in transit between key nodes, or determine if the commodities in storage are at risk of expiring. Figure 4 provides a visual representation

[4] The team researched the following AIDC solutions and technologies: SAP (used by USDA and WFP); ServiceNow – the underlying solution for USAID's HIMS solution; MIT Lincoln Labs Solution design that will be deployed for USAID/BHA; Optel Group's Traceability Solution; Microsoft AX / Dynamics; and, Netsuite (used by MANA Food). The team researched the following Traceability Technology Solutions: 1d Bar codes; QR Codes; RFID Tags; and Block Chain.

[5] Wikipedia, "AIDC", https://en.wikipedia.org/wiki/Automatic_identification_and_data_capture, August 1st, 2020.

of what this system might look like as commodities move through various stages of the U.S. food aid supply chain.

Figure 6: Implementing the QR Code and AIDC Solutions Across BHA's Supply Chain



Source: Adapted from USAID Commodity Management Toolkit (2018)

3.2 QR CODES

A QR code is a two-dimensional barcode that can efficiently hold data in a compact format. QR codes can be read instantly by scanners, even if somewhat damaged or warped. The technology has been around since the mid-1990s and is used around the world for a wide variety of applications. A QR code can hold a substantial amount of information when connected to an external link, and, although there are currently no GSI standards for Micro QR codes, there are GSI standards for QR codes.[6] In addition, it is possible to share certain public information tied to QR codes, while making all other secure information accessible to certain parties.[7]

[6] See "GS1 QR Code GS1 US Guideline" (www.gs1us.org/) and "GS1 General Specifications" (www.gs1us.org/) for reference.

[7] See the report chapter on Institutional, Operational, and Economic Risks for an additional description of W security.

Figure 7: An Example QR Code [8]

QR codes, like any barcode, allow machines to quickly scan and identify properly labelled commodities. Once data is scanned, it can serve several functions, including:

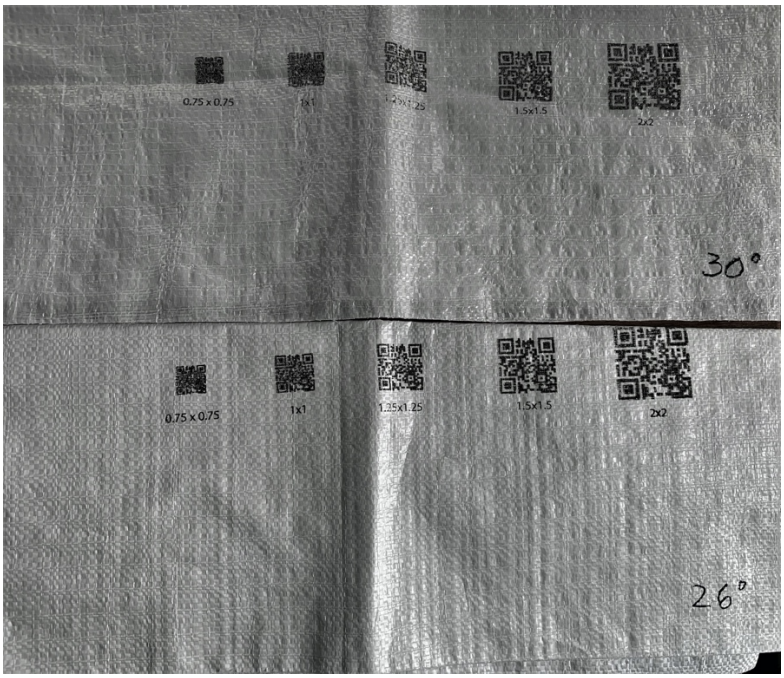
- Tracking of commodity's status at a specific place and time
- Tracing the origin of a commodity in the case of a recall
- Locating the intended destination of a commodity in cases where it has been found in an alternate location
- Accessing instructions for how a commodity should be stored or transported in the future

3.3 QR CODE RECOMMENDATION

The team considered several technologies that could be used to improve the tracking and tracing of the U.S. food aid supply chain. The main technologies included one-dimensional (1D) barcodes, QR codes, and RFID. After speaking with stakeholders from USAID and considering the technical aspects of each technology, the team decided to focus on QR codes. This decision was made for several reasons. First, the investment costs needed to add and use 1D barcodes or QR codes are about the same, but QR codes provide significantly more information. This would allow USAID to add more details about the product, such as end-user recipes and video links. Second, the underlying infrastructure required to operate an RFID system is costly and unavailable in many partner countries or distribution points. This means that the supply chain would only provide limited data visibility. Finally, specialized devices (e.g., mobile scanners) are needed to read RFID data, and it is not always possible to scan densely packed commodities.

[8] Try scanning by orienting your smartphone camera towards the object

Figure 8: QR Code Test Print on Woven Polypropylene Bag[9]



Source: Author's Photo

3.4 QR CODE TYPES

There are various QR code options that BHA could use to improve the tracking and traceability of food commodities in the U.S. food aid supply chain. These options include static, dynamic, and custom QR codes. Below is a brief discussion of each option.

STATIC QR CODES

Static QR codes are codes that redirect the user who scans the QR codes to display predetermined content on their mobile device or take them to a website page. A static QR code was used in USAID's Hybrid Paper Bag Wheat Flour pilot and is currently part of Mana's ongoing traceability pilot .[10] However, static QR codes have limited functionality, as they cannot be edited. This presents limitations when there is a data entry mistake or when batch-level information needs to be updated, such as when there is new information related to the best buy date, food quality, or a recall.

DYNAMIC QR CODES

Dynamic QR codes are codes that can be analyzed, tracked, and edited even after being printed. This means BHA would be able to track and assess the success of QR codes when they are in the destination country getting distributed by partners. They can be edited or updated with correct and or new

[9] 30° and 26° represent degrees of slip resistance

[10] Mana is piloting the use of both static and dynamic QR codes.

information. For example, it would be relatively straightforward to update the best-by date or product recall information.

To use dynamic QR codes, a short URL (Uniform Resource Locator) is needed to redirect users to the desired website landing page. This short URL also collects statistics about the number of scans, geographic location, and date/time of a scan, as well as the operating system used for each scan. This information can help BHA and its supply chain partners track the location of the specific batch of food aid, and over a period of time, get in-depth insights about how U.S. food aid travels through the supply chain. Because it is possible to edit dynamic QR codes even after they have already been printed, this will offer BHA and food suppliers the flexibility to change the encoded content, website data, and even the function of a Dynamic QR Code at any time.

The key limitation of the Dynamic QR code is that it needs an active internet or data connection for it to work. Given that food aid is distributed in many parts of the world where access to live internet might not be available at all times, it would limit its functionality. In other words, anyone without a working internet/data connection would not be able to access information stored on a dynamic QR code until they are able to connect to the internet.

CUSTOM QR CODES

Custom QR codes are codes that are generated using business logic, such as information that should be shown on mobile devices, and data that can be read only by mobile scanners for inserting into warehouse management solutions like HIMS. It can also have both static content that can be accessed without any live internet data connection, and dynamic content like a short URL, which directs users to a dynamic website with updated information. These QR codes offer not only key features of static and dynamic QR code types but also offer future scalability and integration capabilities into different warehouse management and inventory tracking solutions like HIMS, WBSCM, WFP's SAP (System Applications and Products) solution, a potential AIDC solution, and other warehouse management and tracking solutions used by stakeholders across the supply chain.

Another key benefit of using custom QR codes is that it allows complete flexibility to create a QR code design that has all the benefits of various types of codes without any of their limitations. The only drawback is that custom QR codes need to be developed from scratch and require additional effort to develop and test, compared with static and dynamic QR codes

QR CODE TYPE RECOMMENDATION

The team recommends that USAID BHA use custom QR codes in its initial rollout for a limited set of food categories without any integration requirements or complexity. This would enable a quick, low-cost rollout of the QR code solution for the initial phase. It is critical that the custom QR code design have a strong foundation so that it can be enhanced in subsequent phases when the QR code is added to different food commodities (e.g., food aid in 50kg bags). This additional functionality would also be critical when constructing USAID's HIMS solution and USAID/BHA's intelligent food tracking dashboard in partnership with MIT Lincoln Labs. The QR codes will help reduce redundant data entry into HIMS and will provide invaluable real-time data insights for USAID's new intelligent food tracking dashboard.

3.5 INTEGRATING QR CODES

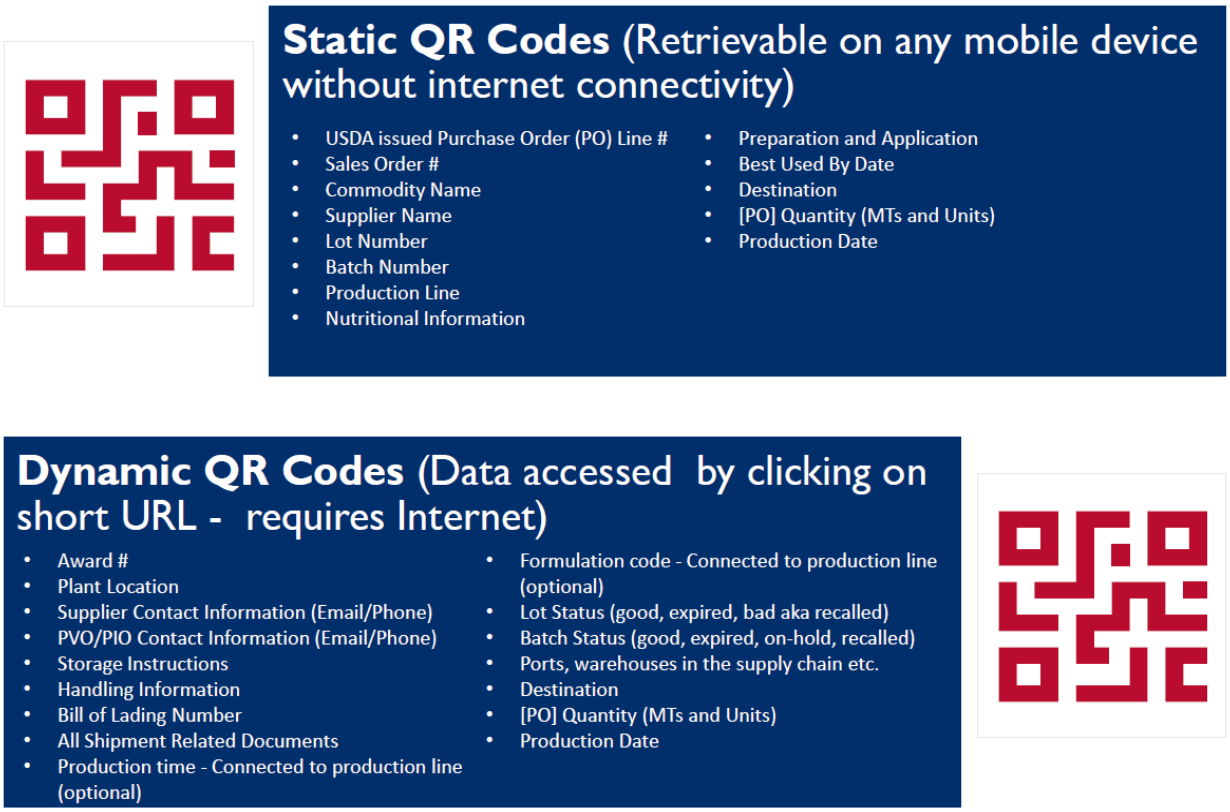
For QR codes to be integrated into various systems, the key stakeholder needs to agree on:

- Data elements (potential data elements shared below),
- QR code format, so that everyone knows how to use the stored data for importing into their respective systems
- Rules for addition, update, and deletion of data elements in the QR code, so everyone is aware of all the information that QR code has and potential changes that occur to QR code data during the course of the food aid's journey through the supply chain.

Once an agreement has been made regarding the basic QR code design, data elements, and rules, the various stakeholder systems (e.g., USAID HIMS, the BHA intelligent food tracking dashboard, USDA's WBSCM, and WFP's SAP) would need to establish data input and output file format options. To start with, the integration, basic Excel-based upload, and download functionality can be deployed using simple flat files. Subsequently, the QR code application would need to publish XML files and or API standards for importing and exporting the QR code data elements. This would allow various stakeholders to decide how they would like to integrate with the new solution and continue to use the QR codes throughout the supply chain even when the food aid is getting distributed by various PVO's in partner countries.

Once these integration options and standards are finalized, it will allow stakeholders like USDA, food suppliers, PVOs, and warehouses to use the same QR codes with their own systems to reduce additional development effort for their tracking and traceability efforts and redundant data entry into their respective solutions. This would also improve visibility, tracking, and traceability across the supply chain and their reporting invaluable data insights to USAID. Key data fields that should be recorded and maintained in the initial QR code design include the information described in Figure 6 on the following page.

Figure 9: Static and Dynamic QR Code Design



Source: Author's representation

3.6 REQUIRED INFRASTRUCTURE

To increase the data visibility associated with QR codes, USAID will need a web-based repository where all QR codes will be generated and provided to suppliers. The QR codes will be based on the agreed-upon specifications (potential data elements listed above), standards (size, shape, color, and the like), and functionality. The web-based server would house all input data from USAID, USDA, WBSCM and suppliers for every QR code that will be generated and maintained.

Because this web-based data repository will house sensitive transactional data, the repository would need adequate access controls to ensure that only authorized users can access and view appropriate data. The access rules and permissions (ability to add, change or view data) should be based on each stakeholder's role in the U.S. food aid supply chain. For example, only authorized USDA users would be allowed to add or update PO numbers and awarded contract information. Similarly, only suppliers would be able to update their batch and quality information for the lot awarded to them. In addition, only suppliers with a required user profile would be able to view certain QR code data fields.

Once the data gets updated in the website, the QR code generation program would generate the QR code, which would be downloaded by the suppliers in a predetermined file format. The file format would be printer or electronic resource planning (ERP) compliant, so that suppliers can upload that file either

directly into their QR code printers or into the ERP (which would then send the QR code data to printers). After the QR code is generated, the web server should have the ability to create the "short URL" dynamic web page that would be viewed when the relevant QR code is scanned along the supply chain. This would ensure all the web pages would have a consistent design and be able to capture scanning data on the same web server.

For the QR codes to be printed properly, all USAID suppliers would need to ensure that their production line printers are capable of printing QR codes on the packaging material. As per our interviews and survey response, the team does not expect any major hurdles to print QR codes on cartons, oil cans, sachets, paper bags, and hybrid bags. Most of the suppliers either have QR code-compliant printers or can add them without too much additional cost. However, USAID would need to work with woven PP bag manufacturers to ensure the printed QR code quality is good enough for the QR codes to last the multiple loading and unloading handling along the long supply chain journey and still retain at least 90 percent level of scanning ability by aid recipients or warehouse scanners in destination countries.

Figure 10: Example of an Unscannable Barcode on a Woven Polypropylene Bag

Source: Author's Photo

Below is a checklist of the key infrastructure required for key stakeholders:

USAID:

1) To create the QR code web-based application, it would need Web-based QR code front-end server(s), application server(s), and database server(s).

2) Accessibility: Desktop, laptops, mobile devices to access the QR code application, and QR code scanning devices in PREPO warehouse to scan QR code data into HIMS.

USDA:

1) If not already available, middleware tool to export and import required QR code data fields in and out of WBSCM.

2) Accessibility: Desktop, laptops, mobile devices to access the QR code application.

Warehouses (PREPO and Regional):

1) Accessibility: Desktop, laptops, mobile devices to access the QR code application.

2) QR code scanning devices in the warehouse to scan QR code data into HIMS and or their proprietary warehouse management system.

Food Suppliers:

1) Production line printers that can print QR codes on the packaging material they use.

2) If not already available, middleware tools to export and import required QR code data fields in and out of their ERP solution.

3) Accessibility: Desktop, laptops, mobile devices to access the QR code application.

4) QR code scanning devices in their warehouse to scan QR code data into their proprietary ERP/warehouse management system.

PVO's:

1) If not already available, middleware tools to export and import required QR code data fields in and out of their ERP solution.

2) Accessibility: Desktop, laptops, mobile devices to access the QR code application.

3) QR code scanning devices in warehouses managed by them to scan QR code data into their proprietary ERP/warehouse management system.

4. OPERATIONAL FEASIBILITY

4.1 OVERVIEW

Management and coordination of the U.S. food aid supply chain will be augmented when the data associated with moving food aid is uniformly collected, stored, and accessible. To make this transition successfully, stakeholders will need to use a gradual, iterative approach to shift from disparate data tracking systems to a common IT system. The team believes this goal can be achieved by implementing the proposed IT solutions over three phases, each with its own objectives and iterative processes. The first phase would require the development of the IT project scope by a cross-functional team of stakeholders. The second phase would include the investments and systems to print, collect, and store QR codes in a data repository. The final phase would involve the collective adoption of an AIDC system.

The team begins this section with a general description of the key stakeholders who make up the U.S. food aid supply chain and the systems they use to capture, store, and share information. The team then describes the institutional factors, such as effective leadership, a comprehensive training plan, and strategic partnerships needed to operationalize the IT solutions effectively. This will be followed with a summary of all past, ongoing, and planned QR codes and AIDC pilots to assess lessons learned and progress to date. The team then discusses the potential path for operationalizing QR codes and an AIDC solution. The section will conclude with a summary list of the key prerequisites for transitioning to a common data tracking system.

4.2 EXISTING SUPPLY CHAIN STAKEHOLDERS AND IT SYSTEMS

The U.S. food aid supply chain consists of many stakeholder organizations, ranging from suppliers and USG agencies to freight forwarders, transport and warehouse operators, PIOs and PVOs, and consumers. Below is a general overview of the key stakeholders grouped by their involvement in the supply chain, including the processes and IT systems they use to manage food aid and the existing capacity of these organizations to add and use QR codes.

- **Commodities and Packaging:** This group of U.S. companies consists of product, ingredient and premix, and packaging suppliers. In addition to their own IT systems, these companies enter commodity data into USDA WBSCM, an integrated, web-based commodity acquisition, distribution, and tracking system. Apart from PP bag suppliers, many of these companies have the capacity to print QR codes or would need to make minor investments or upgrades, as described in the Technical Feasibility section.

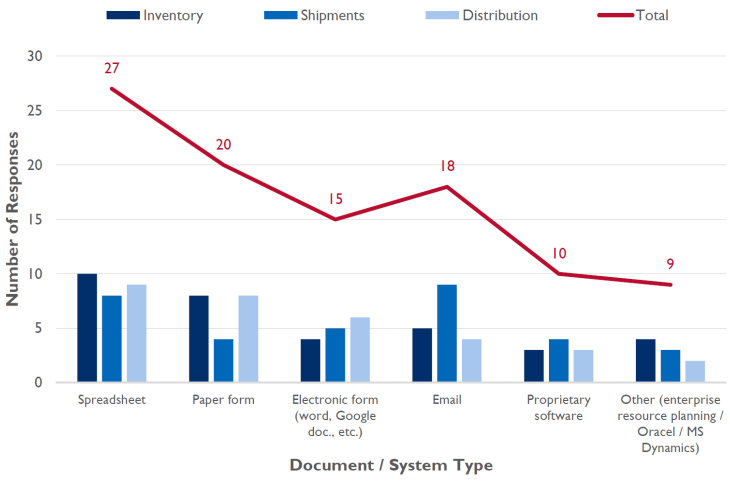
- **Procurement and International Shipping:** USAID, USDA, suppliers, and partner organizations are involved in this stage of the supply chain. In addition to their own IT systems, stakeholders enter commodity data and shipping information into USDA WBSCM. In the commodity solicitation, USAID and USDA set the container specifications and packaging materials requirements to comply with federal food safety regulations and food packaging quality. USAID and USDA would need to update the packaging specifications and requirements to add QR codes to food aid packaging. The required IT investments are described in the previous section.

- **Transport and Shipping:** In addition to USAID, USDA, and partner organizations, this stage of the supply chain consists of freight forwarders, shipping carriers and transport operators, and port authorities. Commodity data is tracked in WBSCM until ownership of the commodity is transferred from the USG to the partner organization. From that point forward, the commodity is tracked through the IT systems used by partner organizations. Partner organizations using proprietary software, such as SAP, could easily integrate QR codes for portions of the supply chain where this common system is used. Although freight forwarders, shipping companies, and transport companies could potentially benefit from the data visibility provided by QR codes, the team does not expect they would use them directly.

- **Product Storage, Handling, and Distribution:** This stage of the supply chain is made up of warehouse operators at various points along the supply chain. Many of these operators have their own IT systems and processes for monitoring food aid shipments and inventories. The investments needed to integrate these existing systems into a common QR code repository or AIDC system are described in the Technical Feasibility section.

The IT systems currently used by stakeholders suggest significant efficiency gains could be realized by increasing data visibility. Many stakeholders use spreadsheets and paper forms to monitor food aid inventories and track commodity shipments and distributions. According to feedback from the 2020 Survey of Food Aid, PIOs, PVOS, and NGOs primarily use spreadsheets, paper forms, and electronic forms to monitor food aid commodity inventories, shipments, and food aid distributions (see Figure 8). Similarly, warehouse operators report using spreadsheets and commercial software to monitor food aid shipments and warehouse inventories, and the most common methods for reporting food aid flows to stakeholders (e.g., USAID, PVOs, PIOs, and the like) is by email and spreadsheets.

Figure 11: Reported Food Commodity Inventory Management and Tracking Systems by PIOs, PVOs, and NGOs



Source: Survey of Food Aid

4.3 LEADERSHIP

In 2012, the GAO performed an assessment of USG IT acquisitions to identify successful investments and the common critical success factors that led to these acquisitions (GAO, 2012). Officials from six out of the seven IT investments identified support from senior department and agency executives as a critical success factor. Given the scale and complexity of the U.S. food aid supply chain, USAID and key partner organizations will need to exhibit the same type of leadership for the successful implementation of QR codes and an AIDC solution.

Several key officials at USAID, in particular, personnel in USAID/BHA's Office of Field and Response Operations, and a select number of representatives from partner organizations are leading the effort to coordinate pilots and establish the foundation for adopting the new technologies. To be successful, however, the initiative will need the active support of senior leaders, such as division chiefs, directors, and administrators. The team believes this support will need to be directed toward four areas, to include:

- **Financial and Human Resources:** USAID leaders will include the approval of financial resources and personnel to assist with the design and implementation of the respective IT systems. This support will be particularly helpful for BHA actions or investments that need to go through USAID's procurement process, which can take some time to navigate.

- **Collaboration with USDA:** USAID leaders will need to support collaborative efforts with USDA to ensure that QR code printing and packaging requirements are specified in solicitations and technical documents. Moreover, USAID leaders will need to support the integration of existing IT systems into a common QR code data repository. This will be critical for the establishment of a web-based server to house all QR code data from WBSCM.

- **Collaboration with Partner Organizations for a QR Code Repository:** USAID leaders will need to engage with senior officials at partner organizations to champion the use of the online QR code repository. USAID leaders should start with organizations where strong relationships exist or solid informational structures are present. World Vision's Last Mile Mobile Solutions (LMMS) is an example of a partner with a strong informational structure.

- **Collaboration with Partner Organizations for an AIDC System:** USAID leaders will need to be proactively engaged in efforts to get stakeholders on board with a common AIDC solution. This support should include consistent communication protocols and guidance, as stakeholders move to common scanning, storage, and reporting procedures. Once again, USAID may want to form strategic partnerships to start rolling out the use of a common system. This does not necessarily need to be the largest partner, but one with a strong potential for success.

4.4 TRAINING

Although there is enormous potential to enhance data visibility, the proposed IT solutions will work only if users have the knowledge and skills to use them. Therefore, any rollout of the IT solutions should be combined with a robust training program customized for each stakeholder group. Based on our stakeholder interviews and feedback from the 2020 Survey of Food Aid, most stakeholders based in the

United States and discharge ports are aware of QR codes, or their organizations have the operational capacity to use the technology. However, stakeholders who are further removed from a reliable IT network do not appear to have the same training or equipment to scan, store, and access information tied to QR codes.

For new systems, such as AIDC, relevant users will need initial and recurring training to ensure that all employees have the knowledge to scan, store, and access data. USAID is currently deploying a similar type of training plan for the integration of HIMS into USAID PREPO warehouses. A similar training plan would need to be developed and deployed across the supply chain.

USAID and partner organizations should set their budgets to accommodate the training and schedule them in accordance with the IT solution timelines. Given the current constraints of COVID-19, this training should be offered both in person and virtually. If possible, stakeholders should coordinate their training plans when implementing the common end-to-end AIDC solution.

4.5 QR CODE PILOTS AND WORKING GROUPS

USAID and its partners are clearly aware of the benefits of improving data visibility throughout the supply chain, which is demonstrated by completed, existing, and planned QR code and AIDC pilots and initiatives (see Figure 9). Although the completed pilots have provided valuable feedback on the existing capacity to print and scan QR codes, ongoing and planned pilots and initiatives are significantly more complex and will provide powerful insights for constructing the AIDC system and processes for scaling technologies.

Figure 12: USAID and Stakeholder Food Aid QR Code and AIDC Pilots

Source: Author's representation

In 2019, USAID completed a pilot to test whether stakeholders would be able to print and read QR codes on hybrid paper bags (25kg) containing wheat flour. The bag supplier successfully printed the QR codes, and the commodities were scanned at the distribution point in Djibouti without any major issues. The

pilot demonstrated the low up-front costs needed to print QR codes. For example, the bag supplier's only equipment cost was a black ink print card, and the estimated incremental cost of adding QR codes was around 5 percent of existing per unit packaging expenses. Although the bag supplier has the capacity to scale up the printing of QR codes, the commodity supplier may be better positioned to add information to the QR code (e.g., batch number, lot number, and the like). At the time of drafting this report, USAID is in the process of developing a similar pilot for packaged commodities destined for USAID PREPO warehouses in Djibouti, Durban, and Houston.

In 2020, WFP implemented the Last Mile Solution in Ethiopia, a pilot involving the printing of QR codes on waybills and the creation of a dedicated mobile platform for electronic scanning and receipt confirmation. The pilot reduced the time it takes to confirm the receipt of food aid from 2-4 weeks, using existing paper-based practices, to less than 48 hours with QR codes. Although results from the Last Mile Solution in Ethiopia were positive, the pilot initially encountered challenges related to the limited number of staff able to scan and use QR codes properly. There were also some issues related to the continuous monitoring of devices and the mobile platform. WFP addressed these challenges by training staff and establishing a standby team ready to address any technical issues.

USAID recently partnered with the Massachusetts Institute of Technology Lincoln Laboratory (MIT LL) to build an Intelligent Food Tracking System and Dashboard to add more flexibility and data visibility to the supply chain. Results from this initiative will be critical to informing the selection and design of an end-to-end AIDC system, as it will construct a common food tracking system using existing information systems and reporting platforms. This will provide a first-hand example of what it will take to move stakeholders to a common information-sharing platform. The end results will also demonstrate how increased data visibility can increase operational efficiencies (e.g., alerts for delays, ordering, expiration dates, shortages, contamination, and the like). The pilot is currently in the design phase with plans to carry out the pilot in Winter 2021.

MANA, a non-profit RUFT supplier, is leading a QR code pilot that provides product details, status updates, and enables real-time responses when an incident occurs. Although MANA is currently using its ERP to host the platform, the goal is to create an Open Traceability platform that is available to all suppliers. Although the QR code currently has batch status and incident responses, the QR code will expand into other features as users gain more experience. The pilot will also provide information as to the level of packaging to which the QR code should be added. Overall, the pilot's aim is to demonstrate the effectiveness of dynamic URL QR codes in tracking (i.e., scanning cases), and tracing as it relates to food incidences and reporting of food quality issues.

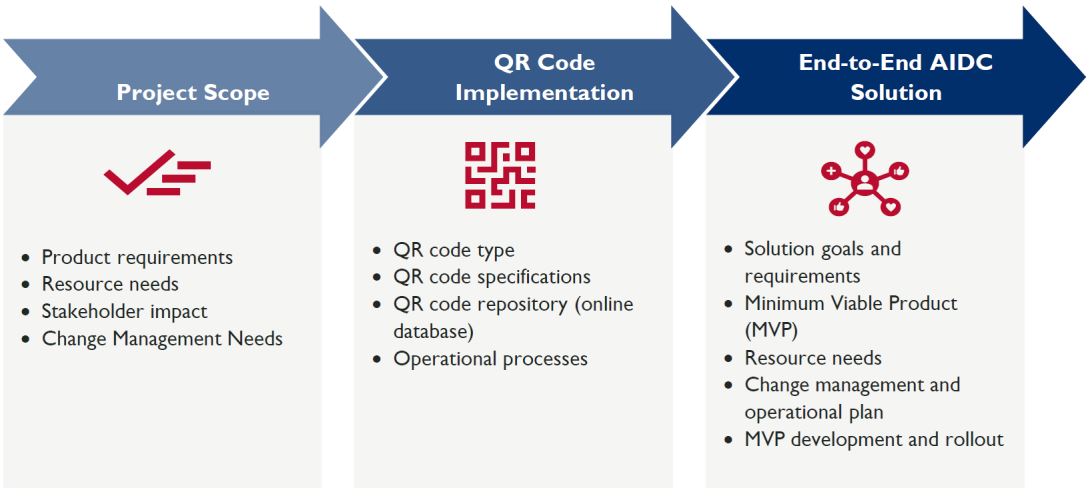
Supply chain stakeholders have also built strong foundations to implement pilots and coordinate common technical solutions. USAID/BHA is currently involved in several working groups responsible for coordinating pilots and establishing common procedures and protocols for adding QR codes to food aid packaging. For example, USAID/BHA has coordinated working group meetings with freight forwarders, suppliers, partner organizations, and other USG officials to identify potential QR Code Data fields to track and trace throughout the supply chain. USAID/BHA is also engaged in international packaging conferences and workshops, such as the 2020 Food Aid Packaging Workshop.

4.6 PHASED IMPLEMENTATION METHODOLOGY

To implement the proposed IT solutions, USAID will need to select a project development methodology that accounts for the complexity of the U.S. food aid supply chain and the existing systems used to track food commodities. One potential option is the waterfall methodology, a linear, sequential approach in which progress flows in one direction—like water cascading down a mountain. This approach works best in stable environments when all the requirements are known and highly interlinked. USAID could use this approach by first developing the technological requirements for the entire supply chain. The project would then be implemented in a series of linear phases, with each phase dependent on the previous one. Although this methodology has potential, developing a solution that is applicable to all food categories, geographic regions, and stakeholders would require significant time and resources.

Another approach is the Agile methodology, which was created as a more flexible alternative to the Waterfall approach. Agile is best suited for projects requiring iterative and incremental processes in which requirements and solutions evolve through the collaborative effort of cross-functional teams and key stakeholders. This approach is best suited for projects that require flexibility and have a high level of complexity or uncertainty. Based on the structure of the Title II supply chain and conversations with multiple stakeholders, the team recommends using a phased approach for implementing the IT solutions, with Agile serving as the primary methodology within each phase (see Figure 10).

Figure 13: Phased Approach for Implementing QR Codes and an AIDC System

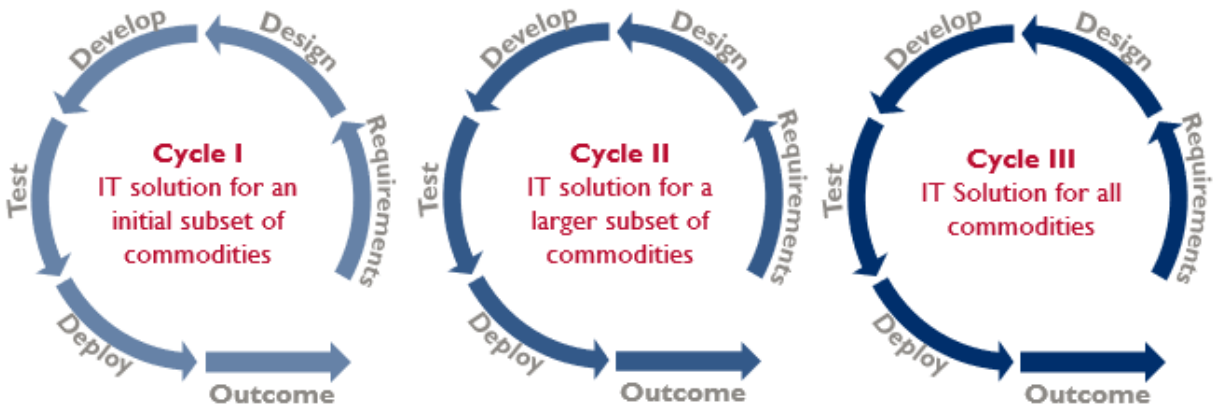


Source: Author's representation

The team primarily recommends using the Agile methodology for several reasons. First, this approach enables USAID to start printing, using, and benefiting from QR codes as soon as it is feasible. Second, the Agile methodology presents the least resistance to change and helps build consensus and common experience towards shared development assistance goals. Finally, this approach will give USAID the opportunity to receive and incorporate feedback before finalizing the solutions. This information will be used to refine the printing, capture, and storage of QR codes, as well as the development of a QR code repository and a common AIDC system. Figure 11 provides a visual representation of the gradual and

iterative approach utilized by the Agile methodology. The first cycle includes the testing of the IT solution over an initial subset of commodities and packaging types. The IT requirements and design are then refined over subsequent cycles until the IT solution is finalized.

Figure 14: An Illustrative Example of Using the Agile Methodology



Source: Author's representation

4.7 PROJECT SCOPE (PHASE 1)

Introducing new technologies can be a long and complex process, especially when the technology is expected to affect supply chain operations and information flows across the globe. One of the first steps is to determine the scope of the project—a collection of inputs, deliverables, and partnerships that must be achieved for successful implementation. The scope should be developed by a cross-functional team of USG officials, stakeholder representatives, and technical development teams. Some factors that need to be included in the scope include:

- A commonly accepted list of product requirements to improve the tracking and traceability of food commodities.
- The resources stakeholders will need to implement the solution, such as capital costs and training.
- The identification of stakeholders who will likely benefit or be negatively affected by the adoption of the new solution.
- The size and complexity of the change, and the impact this will likely have on IT adoption and change management needs.

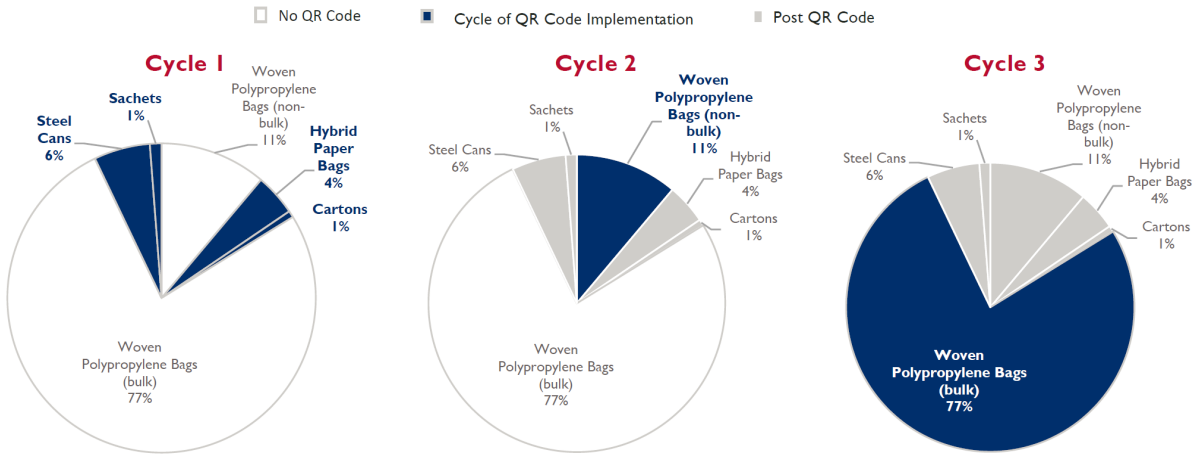
USAID already has or will have much of the information needed to construct the project scope, including results from several QR code pilots; an agreement from many stakeholders for a commonly accepted set of information to be included on QR codes; and, related analyses, such as this feasibility study. USAID will need to bring this information together to construct the project scope, identify strategic partnerships,

and mitigate risk. USAID may also need to partner with an IT provider to design the QR code requirements, the QR code repository, and the AIDC system.

4.8 QR CODE IMPLEMENTATION (PHASE II)

The guiding principle for implementing QR codes should be based on starting small, initially focusing on the "low-hanging fruit," and then refining the approach as more information is acquired. Specifically, the team recommends USAID implement QR codes over three cycles to align with the Agile development methodology and provide ample time for identifying the packaging requirements and printing processes for adding QR codes to certain commodities (see Figure 12).[11]

Figure 15: Phase II QR Code Implementation Cycles by Packaging Type (Metric Tons)

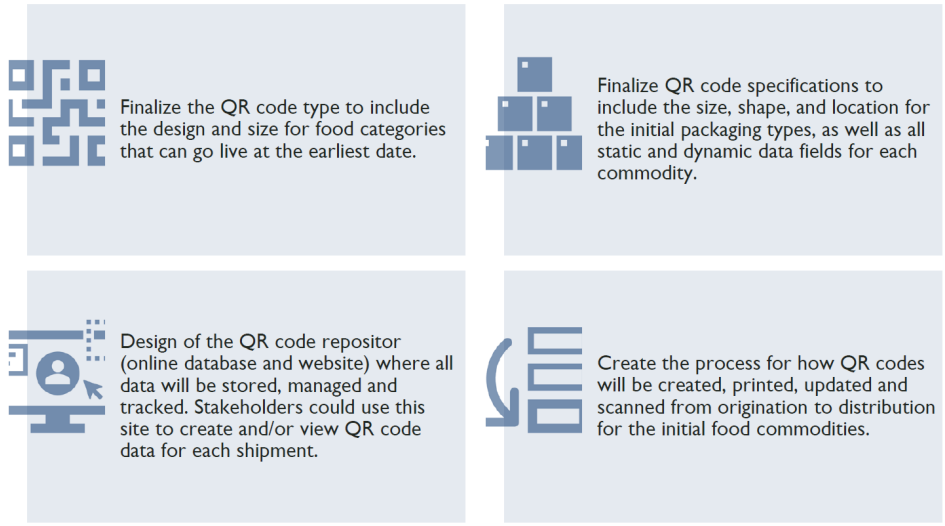


Source: USDA Procurement Data (2011 - 2019); USAID Packaging Data (2019)

The team suggests that the first cycle should be directed toward a subset of food aid commodities and shipment types with the greatest potential for success, such as palletized vegetable oil, RUSF and RUTF packages, and commodities in hybrid paper bags. These goods, which account for approximately 12 percent of U.S. food aid volumes (MT), should be prioritized, because they are supported by motivated suppliers who can quickly add QR codes to their operations. Moreover, this would provide an excellent opportunity for USAID to test a QR code repository design and fine-tune the data integrity, governance, and visibility issues that are paramount to this initiative. This would include the technical design and specifications for the IT solution. Figure 13 on the next page provides a summary of the deliverables associated with the QR code design for these initial products.

[11] USAID food aid volumes (MT) are not commonly reported by packaging type because the actual quantity of packaging types varies (see Figure 2) by commodity. However, Figure 12 represents this information by packaging type to show how many MT of food could be covered by QR codes using the recommended incremental approach.

Figure 16: QR Code Deliverables for Cycle I



Source: Author's representation

Lessons learned through this initial phase of printing, capturing, storing, and accessing QR codes will be used to guide all future implementation. The second cycle should include the printing of QR codes on woven PP bags for prepackaged commodities, which accounts for more than 11 percent of U.S. food aid volumes. This should occur after the first cycle, because it will take time for stakeholders to design a PP bag that can hold the QR codes while retaining the aeration and flexibility of the existing packaging. The third cycle would include the printing of QR codes on PP bags that accompany bulk shipments to discharge ports, which accounts for almost 77 percent of U.S. food aid volumes. This should be the final cycle, due to the complexity of successfully matching bulk commodities to the appropriate QR-coded PP bags at discharge ports.

4.9 AIDC SOLUTION (PHASE III)

Although it will take several years to develop an AIDC solution, a common IT solution for monitoring food aid data, the following steps should be followed when eventually developing this system:

- **AIDC Alignment:** The most important step in developing an AIDC solution is the need to align all the key stakeholders on the goals and objectives of the AIDC solution. This will require support from every level of the stakeholder organizations, including USAID, USDA, suppliers, PIOs, and PVOs. Stakeholders should be able to build on the lessons learned, successes, and strategic partnerships that are established with the implementation of QR codes (Phase II). Without this alignment, it will be extremely difficult for the solution to be adopted across the U.S. food aid supply chain.

- **Business Requirements:** The second step requires USAID to finalize the business requirements for the AIDC solution with input from all key stakeholders. The finalized business requirements should be comprehensive, as they will represent the IT system needs for each stakeholder

organization. The business requirements should specify how the AIDC solution would receive and share data with other stakeholder solutions like WBSCM, HIMS, and WFP's SAP solution.

- **Minimum Viable Product (MVP):** Once the business requirements have been finalized, USAID and stakeholders should use this information to define the MVP. The MVP is the most useful and logically sound system that can be implemented with the lowest time and resource costs. The MVP represents the IT solution that has the highest probability of adoption across the U.S. food aid supply chain.

- **System Socialization:** To increase the likelihood of success, it is critical that the AIDC solution design and implementation plan be socialized with stakeholders. USAID and key stakeholder organizations should hold focus-group discussions, meetings, and workshops to give supply chain participants an opportunity to review the design and provide feedback. This would give stakeholders a sense of ownership over the solution and increase the chances that the centralized system meets the needs of all U.S. food aid supply chain actors.

- **Human Capital:** The process will need to be led by USAID officials with strong professional and leadership skills in the following areas: program and project management expertise, solution design and data modeling, and techno-functional skills that cover both international supply chain and IT technical expertise. The team strongly recommends that members of the USAID/BHA team should be heavily involved in leading this process.

4.10 PREREQUISITES FOR SUCCESS

The team has described some necessary factors for the successful implementation of QR codes and an AIDC solution. Many of these technical specifications and coordination requirements should be rolled out using an iterative Agile development methodology, in which systems and procedures are constantly tested and refined. With this in mind, the team created a summary list of operational and institutional prerequisites that are needed to reach the full potential of the IT solutions. These prerequisites include:

- USAID leadership approval and support for the IT solutions to include budgetary resources, personnel, and collaboration with senior leaders at USDA and partner organizations to align resources under a common QR code data repository and AIDC solution.

- The creation of a cross-functional team (core team) responsible for coordinating efforts and delivering the scope and design for implementing the IT solutions.

- A finalized solution design and technology platform for implementing QR codes and an AIDC system to include integration into existing IT systems like USAID HIMS, USDA WBSCM, and WFP SAP.

- A finalized scope for the initial rollout of QR codes, to include targeted food commodities and a consortium of partners who will champion QR codes at each logistical node. This scope will need to factor in any lead times that are needed for stakeholders to start using QR codes.

- A robust communication plan developed with stakeholder input to include the scope and purpose of the QR code and AIDC solution design and implementation.
- The construction of an MVP solution and the socialization of the MVP with key identified stakeholders for their review and approval.
- A comprehensive training plan to deliver initial and recurring training for the QR codes and AIDC system.
- A working process for adapting to technical and procedural findings across each of the development phases and cycles, including any adjustments to the solution design and packaging materials.

5. ECONOMIC FEASIBILITY

In this section, the team estimates and analyzes the economic impacts of the proposed AIDC and QR code solutions. The team assesses whether the solutions can be considered economically feasible under a variety of different assumptions, meaning whether the quantifiable benefits exceed the costs of the solution. The feasibility criteria have been calculated using a subset of benefits that are defensible. The use of conservative assumptions throughout the analysis adds weight to the overall recommendation.

The team has constructed an economic model that allows the calculation of costs and benefits associated with the new QR and AIDC systems. This model is a flexible set of mathematical equations that allow us to calculate the effects of the program using different assumptions for key inputs, therefore allowing us to explore how the feasibility is affected by changes in the value of inputs and outputs, changes in the timing of the solution rollout, and forecasts about parameters such as the shipping volumes or the discount rate.

In the following sections, the team discusses the assumptions guiding our calculations before briefly discussing our findings related to economic feasibility obtained using the model. For a more thorough explanation of the model's equations and structure, see Annex IV, or view the accompanying spreadsheet.

5.1 MODEL ASSUMPTIONS

The following section describes the rationale behind some of our modelling decisions. For a complete description of the sources of all parameters, as well as the mathematical equations used in the model, see Annex IV.

QR CODE AND AIDC ROLLOUT STRUCTURE

The team assumes that the USG QR code specification will happen first, with its own associated investment costs, and that the AIDC system will follow, with a separate set of associated investment and recurring operational and management costs. As a result, a subset of benefits will begin once the QR codes are included on commodities (those related to tracing) and the majority of benefits related to commodity tracking will begin after a common AIDC system is implemented.

TABLE 1: SUMMARY OF COSTS AND BENEFITS BY IT SOLUTION IMPLEMENTATION PHASE

	ACTIVITIES	COSTS	BENEFITS
QR	QR codes printed on commodities	1 Year of investment costs for design, training, etc.	Tracing benefits after the investment is complete
AIDC	AIDC system implemented	4 Years of investment for design, build, rollout, etc.	Improved data leads to reduced losses, demurrage, etc.

Source: Author's representation

OPERATIONAL TIME HORIZON (15 YEARS)

The team chose a 15-year CBA time horizon in our base scenario. The first five years are primarily construction and design work periods, followed by 10 years of operation. Whereas typically computer software is depreciated fairly quickly, the team expects that a system designed for government and NGO use at this scale will be designed to function for at least a decade. The team considers this to be a conservative time frame for measuring accumulated benefits and believes longer-term benefits are very possible.

THE DISCOUNT RATE (12 PERCENT)

The discount rate for the base scenario is chosen to conform with USAID's CBA Guidelines of an economic discount of 12 percent. The sensitivity of this rate is considered as part of our analysis.

5.2 CBA OUTPUTS

This model can calculate decision criteria like net present value (NPV), breakeven point, and the like. Based on input from USAID/BHA and USAID's CBA Guidelines, a select number of decision criteria will be used to determine under which circumstances the proposed solution is feasible. The findings for these decision criteria are summarized in Table 2.

TABLE 2: DECISION CRITERIA OUTPUT - BASE SCENARIO	
Net Present Value (USD)	$7,089,563
Full Investment Breakeven [12] (Year)	6
Equivalent Food Saved (MT)	13,415.95
Equivalent People Fed (for 1 Year)	67,079.75
Internal Rate of Return	32.05%

Source: QR-CODE-CBA-MODEL.xlsx

The model output supports the economic feasibility of the activities. Although there are numerous uncertainties related to the successful rollout of the solution, the team believes that the model has been coded with relatively conservative assumptions, and the large benefits generated in a relatively short time span suggest that this project has high potential to succeed.

5.3 COSTS AND BENEFITS ESTIMATED

In the following section, the team provides a brief overview of how the costs and benefits in our model were estimated. Note that the costs and benefits described here are only the subset of potential benefits quantified for the purposes of our model (see section 5.6 for further details). The full description of the

[12] Both QR Standards and AIDC System

equations used, parameter estimates and sources, and methodological concerns applicable to each estimate may be found in Annex IV.

BENEFIT 1 - REDUCTION IN COMMODITIES LOST

Improved tracking data could help increase the average volume of food reaching hungry people each year, by detecting and eliminating sources of commodity loss in the BHA logistics chain. Preventable losses like packaging damage, water damage, pest infestations, theft, misplacement, expiration, and other issues occur at various points between procurement and delivery to beneficiaries. With a supply chain as massive as BHAs, reducing or recovering even a small percentage of food losses translates to a significant amount of additional food going to people who need it. Improved commodity tracking could reduce some subset of the preventable losses in the future, under the assumption that improving the quality of data available to the organization would, in turn, allow BHA to address some of the newly identified "pain points" (points where losses occur consistently) in the supply chain.

The quantity of reduction in food losses would be the difference between food lost in the status quo and in the scenario with the intervention, measured in metric tons (MT). Ironically, the reason this benefit is calculated is the existing lack of end to end data visibility, but this, therefore, means that we will need to make some assumptions about the potential change in losses for this analysis. As an upper bound, the value cannot exceed the total losses in the current system. The team estimated total losses in the current system as a starting point and applied an estimated loss reduction factor based on observable improvements in comparable interventions.

The base scenario took the weighted average of total losses estimated by stakeholders at different parts of the supply chain, which resulted in an average estimated loss amount of 1.86 percent. The team also took the weighted average estimates of what amount of that would be reducible with the proper IT solution, which came to approximately 31 percent. Given the size of BHA's operations, this reduction translates into a lot more food delivered. If even a small reduction in losses can be potentially achieved via improved data visibility, the benefits are enough to justify investments into such a system.

The model uses a value for food shipped of $528 dollars per ton. This is based on the 2018 USAID Packaging Data and is calculated by dividing the total spent on food into the total volume of food. These numbers are from BHAs procurement data. The model uses the 2018 numbers for BHA commodity shipping.

BENEFIT 2 - REDUCED DEMURRAGE FEES

When food at a port is not promptly unloaded and moved to its next storage facility, demurrage fees may be charged to the responsible party. These charges are based on the volume of the unmoved cargo and the length of the delay. BHA reported more than a million dollars in demurrage charges in 2014/15 that resulted from commodity logistics inefficiencies.

The AIDC/QR codes could help reduce these costs by improving the quality of data available to relevant stakeholders and improve their ability to optimize logistical procedures at warehouses, ports, and the like. Smart systems could be designed that would make it easier to see where in the supply chain shipments

are being held up and adding demurrage costs so that such issues can be addressed. Alerts could be sent to the responsible parties indicating when they are at risk of incurring demurrage charges.

The reduction in demurrage charges is estimated by multiplying the value of the demurrage charges in the current scenario, with an estimated change in demurrage charges in possible future scenarios. The initial demurrage costs come from historical BHA data, while the expected future demurrage costs are an estimate based on the authors' conversations with stakeholders regarding which portion of costs is preventable.

The annual demurrage fees are an average of the 2014-2016 numbers provided to us by BHA.[13] These numbers are based on more than $2 million in demurrage costs incurred by WFP over those years, and therefore could be a lower bound. The model, therefore, assumes $700,000 in demurrage charges annually and applies a loss reduction factor of 50 percent.

BENEFIT 3 - REDUCED TRACING COSTS

If commodities have information-rich QR codes printed of them, it should be easier to manage recalls, since the relevant data points (such as batch #, packaging date, and the like) will be accessible to any warehouse worker who scans a package with their phone. The recall process will be even easier if a fully integrated AIDC system is implemented. If commodity locations are recorded into a central database, the recall process could be as easy as simply updating the status of a subset of commodities to "recalled," and the system could send updates to the party in possession of the relevant commodity. The value of this benefit will depend on both the expected cost of recalling food in the absence of the solution over the timeframe analyzed and the impact of QR codes or AIDC systems on these costs.

The team builds on a 2010 paper of traceability benefits in the beef industry, which found that the cost of recalls was equal to the total value of the commodity recalled, plus approximately 10 percent for logistical management and 4 percent for communications.[14] Because the logistical costs and communication costs are the components that would be affected by the solution, the team assumes that 14 percent of the underlying commodity value can be addressed by improved traceability. Fourteen percent is the upper bound for our benefit in the model, and then, we apply the reduction factor that corresponds to the overall effectiveness of the new system.

The team was able to access loss and damage reports from BHA for 2019, in which approximately 8,000 MT of food was recalled. This value is used as a basic estimate of the annual average volume of food recalled. We then consider the impacts of a 25 percent reduction in these extra costs because of the first and second phase solution (QR codes) being rolled out. QR codes alone should make tracing commodities much easier, as they can allow anyone with a phone to learn where, when, and how a commodity was created and packaged, removing significant ambiguity from the existing recall processes.

[13] Original AIDC white paper, and follow-up emails with Budget and Finance Division for USAID's Bureau for Humanitarian Assistance (BHA).

[14] "Economics of traceability for mitigation of food recall costs", Resende-Filho, Moises and Buhr, Brian, 27 December 2010

Although not included in the model, there are potentially more benefits from a more granular marking of commodities, as a smaller subset of production can be recalled, and overall fewer commodities will be recalled unnecessarily due to the inability to differentiate them from others in their PO.

COST 1 - FIXED UPFRONT INVESTMENTS COSTS[15]

TABLE 3: ASSUMED INVESTMENT COSTS IN BASE SCENARIO		
INVESTMENT ITEM	**QR CODE**	**AIDC**
Training	$100,000	$100,000
Design Finalization	$50,000	-
Printing Capability Subsidy	$100,000	-
HIMS Integration	$50,000	-
System Design and Build	-	$1,800,000
Promotion	-	$100,000
TOTAL	**$300,000**	**$2,000,000**

Source: QR-CODE-CBA-MODEL.xlsx

The model includes the immediate costs of the proposed solutions that must be paid before any benefits can be actualized, including designing the upgrading equipment to ensure QR labels can be output, adding scanning capacities to warehouses or ports, installing secure servers to host the relevant platforms, and the like. The team believes these estimates are conservative, and that with competitive procurement, the true cost could be lower.

[15] See Annex VI for an illustrative budget of adding and using QR codes at one USAID PREPO warehouse.

COST 2 - OPERATIONAL COSTS

TABLE 4: OPERATIONAL COSTS		
ANNUAL	**QR CODE**	**AIDC**
Ongoing Training/Refreshers	-	$150,000
Staff	-	$100,000
IT Operations and Maintenance	$20,000	$50,000
TOTAL	**$20,000**	**$300,000**

Source: QR-CODE-CBA-MODEL.xlsx

The model also includes the operational cost of maintaining and running the web server that hosts the QR code standards and the AIDC system. All suppliers and partners would be able to visit this to check and maintain the QR codes for various food commodities/products. These cost estimates are based on this team's experience of managing similar cloud-based solutions in the past for large international food companies involved in the supply chain and distribution sector for agricultural commodities.

COST 3 – INCREMENTAL PRINTING COSTS

In our model, we consider the additional cost that may be incurred by adding QR codes to woven PP bags. This extra cost could be associated with changes to the design or material specification of bags or could represent additional processes, such as stitching a label onto the bag. Because the woven bags comprise the majority of packaging in the supply chain, the marginal costs of changing specifications are significant and will need to be further investigated before proceeding to the full AIDC rollout.

We use the survey data to estimate an additional cost of 59 cents per bag, though there are many suppliers who responded that they didn't know what the marginal cost of QR printing would be, and therefore, we consider alternate values for our scenario analysis. Based on our conversation with bag suppliers, we learned that in a worst-case scenario, if printing is impossible on the woven bags, tags could be sewn on for an estimated 11.5 cents per bag. We use this value as an upper estimate in our additional scenarios.

5.4 SCENARIO ANALYSIS

Given the significant uncertainty in estimating future impacts related to the proposed solutions, our team has decided to analyze the outputs of the model under different scenarios. For more in-depth consideration of how different inputs affect the model, see section 6.

ALTERNATE SCENARIO—HIGH PRINTING COSTS PER BAG WITH FULL AIDC IMPLEMENTED

In the base scenario, we have used the weighted average cost estimate from suppliers (0.059 USD). However, the true cost of printing QR could conceivably exceed this, especially if there are issues with printing on the PP bags that require some costly alteration to the stitching or printing process. We assume that for the worst-case scenario, the printing cost for bags will be as high as 11.5 cents per bag. This was the estimate one supplier gave us for sewing an additional printed tag onto bags, and thus we believe this is a reasonable upper bound for costs. In this scenario, the outputs of the model are less attractive.

TABLE 5: ALTERNATIVE SCENARIO (HIGH PRINTING COSTS) MODEL OUTPUTS	
Net Present Value (USD)	-$272,382
Full Investment Breakeven [16] (Year)	>10 Years
Equivalent Food Saved (MT)	NA
Internal Rate of Return	11.31%

Source: QR-CODE-CBA-MODEL.xlsx

ALTERNATE SCENARIO—HIGH PRINTING COSTS PER BAG WITH AIDC ABORTED

In this scenario, we consider the possibility that the AIDC system is unable to materialize, perhaps due to an inability to reach consensus among key stakeholders. The investment costs are incurred for two years, but the cancellation of the contract allows some costs to be averted. The results are below.

TABLE 6: ABORTED AIDC	
Net Present Value (USD)	-$597,107
Full Investment Breakeven [17] (Year)	>10 Years
Equivalent Food Saved (MT)	NA
Internal Rate of Return	0.76%

Source: QR-CODE-CBA-MODEL.xlsx

[16] Both QR Standards and AIDC System

[17] Both QR Standards and AIDC System

5.5 NON-QUANTIFIED BENEFITS

In our model, the team is able to quantify the value of only some of the improvements that result from the improved tracking and tracing of food commodities. Some benefits are more difficult to forecast and estimate accurately but may be just as relevant motivations for implementing the solutions. Some of these include:

IMPROVED ACCOUNTABILITY AND REPORTING

The improvements to data collection would improve the overall accountability of title II food aid. In recent years, the Government Accountability Office (GAO) has found the existing food aid tracking systems lacking and determined that updates to processes are needed. The new solutions could improve the trust that politicians and taxpayers have in the program, ensuring its long-term sustainability.

BETTER BENEFICIARY EXPERIENCE

One potential use for QR codes is the delivery of instructions or messages to beneficiaries. The codes could contain nutritional information or have instructions for storage and preparation. This could improve nutritional outcomes and user experience. It could also help effectively communicate the USAID branding to beneficiaries.

BETTER TRACING OUTCOMES

The model currently values the tracing benefits as a reduction in costs to staff. There are other potential benefits, however, that we are not able to estimate, such as the potential to avoid adverse health outcomes through quicker location and removal of dangerous commodities. The benefits here include the better outcomes themselves, as well as the avoided damage to the USAID/BHA reputation and public relations outfall.

REAL-TIME DATA AVAILABILITY FOR DECISION MAKERS

The availability of data is a benefit that is partially captured through the benefits of the model. However, the ability to see where commodities are, in real-time, could be valuable beyond the loss detection and improved logistical management already in the model. In a crisis, the availability of data could help decision-makers dispatch food to the needy more efficiently or detect breakages in the supply chain in time to fix bottlenecks.

6. INSTITUTIONAL, OPERATIONAL, AND ECONOMIC RISKS

6.1 OVERVIEW

The team has identified several risks and challenges related to the technical, operational, institutional, and economic aspects of implementing the IT solution. In the context of the U.S. food aid supply chain, the team considers an institution as any U.S. Government agency or partner organization that is responsible for supplying, transporting, storing, or delivering food aid commodities to beneficiaries. Using this premise and the research findings presented in the feasibility analysis sections, the team has identified several key challenges and risks that are outlined below.

FAILURE TO CREATE A COLLABORATIVE AND HOLISTIC PLAN FOR IMPLEMENTING THE IT SOLUTIONS

The U.S. food aid supply chain is a complex system consisting of multiple stakeholders and geographically dispersed logistical nodes. If USAID and other stakeholders cannot agree on a well-coordinated, holistic approach for rolling out the new technologies, such as common IT requirements and realistic timelines, then the potential benefits of adopting these solutions will not be realized. The expectations and adoption of timelines will differ based on the stakeholder's role within the supply chain. USAID and USDA, for instance, will need to specify the appropriate reporting systems, lead times, and packaging requirements for printing QR codes and reading this information into a common AIDC system. Similarly, downstream supply chain actors, such as partner country transporters and warehouse operators, will need to have the means, lead times, and systems for implementing the new solutions, including the financial resources to invest in scanning equipment and the necessary IT data systems to store and access information.

LIMITED ADOPTION OF QR CODES OR THE AIDC SOLUTION

Even if USAID creates a holistic plan for implementing QR codes and an AIDC solution, there is no guarantee that stakeholders will adopt the IT solutions. This risk is greater for international organizations with large bureaucracies and complex existing IT systems for tracking and tracing food commodities. There might also be some hesitancy from stakeholders to share information that they think might reflect poorly on their operations. If this happens, stakeholders may develop their own QR code standards or tracking systems that will be disconnected from the proposed IT solutions. This would limit the potential benefits of tracking food commodities under a common supply chain management information system.

LIMITED BUY-IN FROM SENIOR LEADERS AND STAFF TURNOVER

Although bar scanning technologies have existed for more than 45 years, they have not been added to food aid packaging, despite the modest investment requirements. This implies that any effort to implement QR codes and an AIDC system will need the active support of senior leaders and "champions" from each stakeholder organization. Without this support, there is a significant risk that QR codes will not be

scanned and reported as commodities move along the supply chain. Moreover, the adoption of a common AIDC system would be virtually impossible without support from senior leadership.

A handful of officials in several key organizations have been instrumental in coordinating stakeholder groups, developing pilots, and coordinating evaluations such as this feasibility study. If these "champion" officials were to leave their current posts, the momentum for modernizing the food aid supply chain could be seriously delayed or stopped.

INADEQUATE TRAINING AND INFORMATION SHARING

The successful implementation of technologies depends on the ability of staff to use and support the new systems. If staff do not have the proper training to capture, access, and update the commodity data using the new systems, there will be limited improvements to food commodity tracking and tracing. The support staff will also need to have the proper training and user documentation to assist with the deployment and recurring use of the IT solutions. The level of support would vary by the supply chain role and existing technical capacity of the stakeholder organization.

In addition to possessing the necessary capacity to use the new technology, stakeholders will need to share this information with other supply chain actors to truly benefit from the IT solutions. Initially, there may be some reluctance to share this information as errors arise, trust is gained, and procedures for collecting information are updated. Any slowdown in the sharing of information will also reduce the iterative process of learning and adapting to the AIDC and QR code solutions.

DATA SECURITY CONCERNS

As stakeholders work through the design and specification of the IT solutions, the decision-making process may be hindered by each organization's security concerns. This could be especially problematic as stakeholders consider the integration of the new IT solutions with their own legacy systems. For example, there may be concerns for how information is shared between USDA's WEBSCM system, USAID HIMS, and proprietary systems (e.g., WFP SAP) at different stages of the supply chain. Data security issues may also slow the rollout of the new IT solutions if USAID decides to procure the design and implementation of the technologies using traditional government procurement processes.

MANAGING EXPECTATIONS AND RISKS

Senior officials and other stakeholders will need to be cognizant of the internal and external risks associated with each phase of the IT solution rollout. They must also be willing to accept a certain level of risk. If stakeholders are unsure of the risks or are unable to accept a certain level of risk, then momentum could be slowed when issues arise. This would result in actors not having the information they need to adapt their processes and refine the technologies. The problem could start when senior officials have unrealistic expectations for what the technologies can deliver or how soon stakeholders will adopt a common AIDC system.

TECHNICAL STANDARDS

The implementation team should publish and align on the QR code data standards and AIDC solution APIs with all stakeholders. As much as possible, a cloud-based technology platform should be used for developing the AIDC solution to avoid connectivity issues from different parts of the world.

6.2 ECONOMIC UNCERTAINTIES

As part of the modelling process, the CBA team has examined how deviations in our assumptions affect the overall impact of the solution. If the true value of key parameters is significantly different from our estimates, the outputs of our model will differ as well.

REDUCTION IN LOSSES

The amount that an AIDC system will be able to reduce losses successfully has a very large bearing on the total impact of these solutions. The discounted net benefits increase by more than $1 million USD for each 5 percent reduction in estimated losses.

TABLE 7: SENSITIVITY OF NPV TO LOSS REDUCTION %

LOSS REDUCTION (PERCENTAGE)	DISCOUNTED NPV
0.00%	-$ 8,684,230.24
10.00%	-$ 3,554,541.51
25.00%	$ 4,139,991.59
30.75%*	$ 7,089,562.61
50.00%	$ 16,964,213.42
100.00%	$ 42,612,657.08

Source: QR-CODE-CBA-MODEL.xlsx

As the table above shows, the reduction in losses has a large impact on the net benefits of the program. However, even if the loss reduction factor is zero, the solutions will still generate net positive benefits, because of the benefits like reduced demurrage fees, improved recall efficiency, and the like.

SYSTEM DESIGN COSTS

The amount of money required to fully design and construct the technical solution facilitating AIDC could fall within a fairly wide range. We consider the potential impacts of cost overruns on the net benefits of the intervention in the table below. The base scenario would see positive benefits for systems much more expensive than the million dollars we have assumed in the base model.

TABLE 8: SENSITIVITY OF NPV TO SYSTEM DESIGN AND IMPLEMENTATION COST	
AIDC SYSTEM COST (USD)	**DISCOUNTED NPV**
$ 500,000.00	$ 8,365,249.34
$ 1,000,000.00	$ 7,940,020.43
$ 1,500,000.00	$ 7,514,791.52
$ 2,000,000.00	$ 7,089,562.61
$ 3,000,000.00	$ 6,239,104.80
$ 5,000,000.00	$ 4,538,189.16

Source: QR-CODE-CBA-MODEL.xlsx

As observed in the table above, the NPV of the model still remains positive, even with costs in the multi-millions. The team does not necessarily believe that such costs overruns are expected or reasonable, but believe that this further reinforces the likelihood of success.

DISCOUNT RATE

The discount rate is a percentage reduction factor applied to future costs and benefits that compounds with time. The team used 12 percent as a base discount factor, as is standard practice for USAID models.

TABLE 9: SENSITIVITY OF NPV TO DISCOUNT RATE	
DISCOUNT RATE	**DISCOUNTED NPV**
0%	$ 24,813,267.77
2%	$ 20,098,146.17
5%	$ 14,710,673.35
10%	$ 8,756,818.00
12%	$ 7,089,562.61
15%	$ 5,112,311.17

Source: QR-CODE-CBA-MODEL.xlsx

The NPV is especially sensitive to changes in the discounting rate because of the 15-year time frame of the model and the relatively long investment period for the AIDC system. The 12 percent we have used in the base scenario is relatively high compared to what is used in most models, and we do not believe that higher values are relevant.

MARGINAL COST OF QR CODES ON PP BAGS

Given some potential difficulties with the scanning of QR codes printed on woven PP bags, product specifications may need to be modified in terms of design (for example, to have one side laminated). As a result, there could be an increase in the procurement cost of woven PP bags. The following table shows that as we add marginal cost to the PP bags, the NPV of the project as it is currently modeled dips significantly, because woven PP bags are used for more than three-quarters of BHA food aid, meaning that even if the cost is only a few cents per bag, the total is significant.

TABLE 10: SENSITIVITY OF NPV TO MARGINAL PER BAG COST	
ADDITIONAL COST PER BAG (USD)	**DISCOUNTED NPV**
$ -	$ 14,778,704.34
$ 0.020	$ 12,161,124.18
$ 0.059*	$ 7,089,562.61
$ 0.080	$ 4,308,383.69
$ 0.100	$ 1,690,803.53
$ 0.150	-$ 4,853,146.88

Source: QR-CODE-CBA-MODEL.xlsx

The marginal cost of adding QR codes is acknowledged by the study team as a significant impact on the success of the project, and we therefore recommend that before the rollout of the program, BHA work with USDA to pilot the procurement of commodities with the new specifications and determine if there is a significant change in price. If so, this may be a reason to cancel or rework the later phases of the solution.

TIMEFRAME OF ANALYSIS

TABLE 11: SENSITIVITY OF NPV TO TIMEFRAME	
# OF YEARS ANALYSED	**DISCOUNTED NPV**
10 Years	$ 3,508,927.01
15 Years	$ 7,089,562.61
20 Years	$ 9,121,311.41
25 Years	$ 10,274,180.25

Source: QR-CODE-CBA-MODEL.xlsx

CHANGING TRENDS IN FOOD PROCUREMENT VOLUME

TABLE 12: SENSITIVITY OF NPV TO TIMEFRAME	
% CHANGE ANNUALLY IN ANNUAL FOOD AID PROCURED	**DISCOUNTED NPV**
-10%	$ 1,285,399.35
-5%	$ 3,579,525.30
0%*	$ 7,089,562.61
5%	$ 12,441,534.76
10%	$ 20,578,748.25

Source: QR-CODE-CBA-MODEL.xlsx

7. CONCLUSIONS AND RECOMMENDATIONS

This final section summarizes the main conclusions from the technical, operational, and economic feasibility analyses of the IT solutions that could be utilized by stakeholders in the U.S. food aid supply chain. It also provides recommendations as to the next steps for the design and implementation of these IT solutions. These recommendations are motivated by USAID/BHA's overall goal of transitioning to a comprehensive system for accessing and sharing food aid data—from the time the commodity is packaged to the final distribution point where commodities are given to beneficiaries.

7.1 CONCLUSIONS

As U.S.-sourced commodities move along the supply chain, stakeholders use their own IT systems for sending, validating, and reconciling food aid deliveries. The result is a supply chain structure where fragmented information flows impede the full potential of effectively managing and tracking food aid commodities. The use of disparate systems also presents challenges with tracing food commodities when there are recalls or food quality issues.

A significant number of stakeholders use spreadsheets and paper forms to monitor food aid inventories, and to track U.S. food aid shipments and distributions. According to feedback from the 2020 Survey of Food Aid, partner organizations primarily use spreadsheets, paper forms, and electronic forms to monitor food aid commodity inventories, shipments, and food aid distributions. Similarly, warehouse operators report using spreadsheets and commercial software to monitor food aid shipments and warehouse inventories, while the most common methods for reporting food aid flows to stakeholders (e.g., USAID, PVOs, PIOs, etc.) is by email and spreadsheets.

USAID is considering the use of QR codes over several other technologies due to issues of affordability, availability, and the amount of information that can be added to a QR code. Specifically, QR codes provide more information than a 1D barcode, yet the implementation costs are similar. In addition, the underlying infrastructure required to operate an alternative technology like RFID is costly and unavailable in many partner countries or distribution points. Moreover, there may be technical issues with properly scanning and updating food aid commodities using RFID in partner country warehouses.

USAID and its partners are clearly aware of the benefits of improving the data visibility of food commodities, which is demonstrated by completed, existing, and planned QR code and AIDC pilots and initiatives. The completed pilots have provided valuable feedback regarding the existing capacity and costs to print and scan QR codes. Specifically, they have demonstrated that suppliers have the capacity to add QR codes, and the marginal costs are low for the piloted packaging types. However, the staff at the distribution points need adequate training to properly scan and use the QR codes. Ongoing and planned pilots are significantly more complex and will provide powerful insights for constructing the AIDC system and processes for scaling technologies.

Supply chain stakeholders have built strong foundations to implement pilots and coordinate common technical solutions. USAID/BHA is currently involved in several working groups responsible

for coordinating pilots and establishing common procedures and protocols for adding QR codes to food aid packaging. USAID/BHA is also engaged in international packaging conferences and workshops, such as the 2020 Food Aid Packaging Workshop.

Although it is possible to add QR codes on most food aid packaging types with limited modifications or investments, it is not yet possible to use QR codes on the existing packaging design for woven polypropylene (PP) bags. Investments and adjustments are needed to add and use QR codes on food aid commodities like palletized vegetable oil, RUSF and RUTF packages, and commodities in hybrid paper bags. However, the existing material used on PP bags does not retain the QR code as it moves across the supply chain, meaning that it is impossible to scan PP bags once they reach partner countries.

Although officials at USAID and partner organizations are actively leading the effort to coordinate pilots and establish the foundation for adopting the IT solutions, senior leaders from each stakeholder organization are not yet promoting these technologies. With that said, USAID/BHA's Office of Field and Response Operations is building the business case for using these technologies, including pilots and this feasibility study, which will be communicated to senior leaders in the near future.

There is a solid economic argument for investment in tracking and tracing. The team met with numerous stakeholders from around the world and discussed the costs inherent in the current way food aid is tracked and traced. The team modeled the estimated long-term impact of reduced losses, reduced demurrage charges, and increased recall efficiency. The results were optimistic and suggested that the benefits of better data visibility can be large. The sheer scale of the food aid supply chain means that even marginal improvements are high value and warrant significant upfront investment in long-term solutions.

However, small changes in the marginal costs of commodity packaging would be costly when extended to the entire supply chain. The team is not certain whether there would need to be changes to the specifications for packaging, such as woven PP bags, which are used for the majority of BHA's supply. Even a marginal cost of five cents per bag would make the net present value of the solution negative (as modeled in the base scenario). If BHA finds that the cost of procurement for commodities increases by more than a cent per 50 KG bag (20 cents per MT), the economic argument needs to include larger benefits (via larger loss reduction, for example), or it will no longer be viable.

7.2 RECOMMENDATIONS

USAID and other stakeholders will need to agree on a well-coordinated, holistic approach for rolling out new technologies, such as common IT business requirements and realistic timelines for adoption. The expectations and timelines will differ based on the actor's role within the supply chain. USAID and USDA, for instance, will need to specify the appropriate reporting systems, lead times, and packaging requirements for printing and using QR codes in a common AIDC solution. Similarly, downstream supply chain actors, such as PVO transport and warehouse operators, will need to have the means, lead times, and systems for implementing the new solutions, including the financial resources to invest in the necessary IT data systems and scanning equipment.

End-to-end data visibility for USAID is completely dependent on the cooperation of partner organizations. The team has considered a number of ways that data visibility can be improved; however, the common factor was always the need for data sharing. USAID can attempt to make this process as easy as possible for partners, by adding easily scanned QR codes and creating an easy to access AIDC system. However, they will need their partners to buy into the overall objective of increasing transparency and data sharing if results are to emerge.

Stakeholders will need to use a gradual and iterative approach to shift from disparate data tracking systems to a common AIDC system. The team believes this goal can be achieved by implementing the IT solutions over three phases, each with its own objectives and iterative processes. The first phase involves the development of the project scope by a cross-functional team of supply chain stakeholders. The second phase would include the investments and systems needed to print, collect, and store QR codes. The final phase would involve the collective adoption of an AIDC system.

The initiative will need the active support of senior leaders, such as division chiefs, directors, and administrators, to successfully implement the IT solutions. This will include the approval of financial resources and personnel to assist with the design and implementation of the respective IT systems. USAID senior officials will also need to engage proactively with senior officials at partner organizations to champion the initial use of an online database to maintain the QR codes data and the eventual adoption of a common AIDC system. The team recommends that USAID leaders start with those organizations where strong relationships exist or where solid informational structures are present.

USAID should implement QR codes (Phase II) over three cycles to provide ample time for identifying the packaging requirements and printing processes for adding QR codes to certain commodities. The first cycle should be directed toward a subset of food aid commodities and shipment types with the greatest potential for success, such as palletized vegetable oil, RUSF and RUTF packages, and commodities in hybrid paper bags. The second cycle should include the printing of QR codes on PP bags for prepackaged commodities. The third cycle would include the printing of QR codes on PP bags that accompany bulk shipments to discharge ports. It is especially important to pilot the PP woven bags that, given they are used for the majority of the BHA food aid supply, and given that the success of this solution depends on figuring out how to print easily scanned QR codes at a minimal cost.

USAID should use custom QR codes in its initial rollout for a limited set of food categories without any integration requirements or complexity. This would enable a quick and low-cost rollout of the QR code solution for the initial phase. It is critical that the custom QR code design has a strong foundation so that the QR code can be enhanced in subsequent phases when it is added to different food commodities. This additional functionality would also be critical when integrating existing IT solutions (e.g., USAID's HIMS solution).

USAID will need to work collaboratively with USDA, suppliers, and partner organizations to design PP bags that can hold the QR codes while retaining the aeration and flexibility of the existing packaging. Based on discussions with several food aid packaging suppliers, it is not possible to print a QR code on a 50 kg PP bag due to the sheen of the existing packaging material. Some potential solutions include a half-laminated PP bag, smaller PP bags that will better hold and retain the QR code, and patching the QR code into the existing PP packaging type.

USAID and partner organizations will need to develop a process for packing bulk commodities into PP bags containing the QR codes. Millions of PP bags accompany bulk shipments to the discharge ports where the commodities are matched and packaged in the appropriate PP bags. Therefore, it is theoretically possible to match the bulk commodity to the relevant QR code bag once a new PP packaging type has been designed. However, stakeholders feel that the existing processes do not always result in the proper packaging of bulk commodities, which would result in data integrity issues as commodities move along the supply chain.

To implement an AIDC solution, all stakeholders will need to align under common goals and objectives, incorporate the IT business requirements of each actor, and develop a minimum viable product (MVP). USAID and stakeholders will need to build on the lessons learned, successes, and partnerships that are established with the implementation of QR codes (Phase II) to align on the common goals of an AIDC solution. USAID will also need to work with stakeholders to finalize the AIDC business requirements, which should specify how the AIDC solution would receive and share data with other systems like WBSCM, HIMS, and WFP's SAP solution. USAID will also need to develop an MVP, the most useful and logically sound system that can be implemented with the lowest time and resource costs. The MVP will represent the solution that has the highest probability of adoption.

To increase the likelihood of success, the AIDC process will need to be led by USAID officials with strong technical and leadership skills. USAID staff should have expertise in the following areas: program and project management, solution design and data modeling, and techno-functional skills that cover both international supply chain and IT technical expertise. The team strongly recommends that members of the USAID/BHA team should be involved in leading this process.

It is also critical that the AIDC solution design and implementation plan are socialized with stakeholders. USAID and key stakeholder organizations should hold focus-group discussions, meetings, and workshops to give supply chain participants an opportunity to review the design and provide feedback. This would give stakeholders a sense of ownership over the solution and increase the chances that the centralized system meets the needs of all U.S. food aid supply chain actors.

Any rollout of the IT solutions should be combined with a robust training program customized for each stakeholder group. This will be particularly important for stakeholders who are further removed from a reliable IT network, who may not have the information or training to scan, store, and access information tied to QR codes. USAID and partner organizations should set their budgets to accommodate the training and schedule them in accordance with the IT solution timelines. Given the current constraints of COVID-19, this training should be offered for both in-person and virtual attendance.

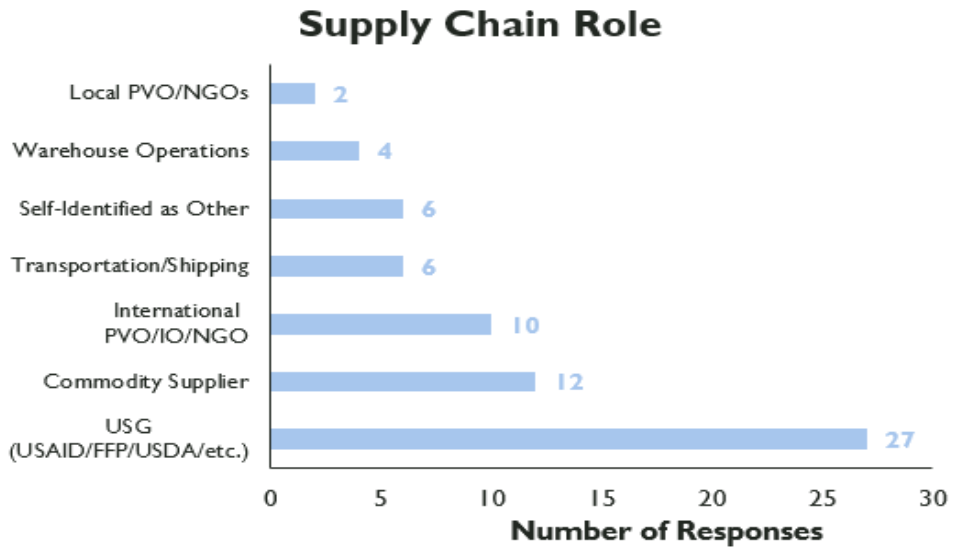
ANNEX I: STAKEHOLDER INTERVIEWS

TABLE 13: LIST OF STAKEHOLDERS ORGANIZATIONS INTERVIEWED	
ORGANIZATION	**DATE**
UFFP	2020-01-28
BKA Logistics	2020-01-29
BHA - IT	2020-01-30
USAID	2020-01-30
USAID/M/OAA/Transportation	2020-01-30
CACI (for USDA)	2020-01-30
USAID - M&E	2020-01-30
Missionary Expediters	2020-01-31
Fetig and Donally	2020-01-31
USAID/M/OAA/Transportation	2020-01-31
LifeLink Logistics	2020-01-31
Polysac (Bag Manufacturer)	2020-02-04
GAO	2020-02-04
Palmer Logistics	2020-02-05
Stratas (Food Supplier - Veg Oil)	2020-02-05
USDA/ AMS/ KCCO	2020-02-06
WFP	2020-02-10
Geodis	2020-02-10
USDA	2020-02-11
World Vision	2020-02-12
USAID	2020-02-12
Mana Nutrition	2020-02-12
USDA	2020-02-12
Intertek	2020-02-19
USDA	2020-02-19
Agribag	2020-02-19
Itech	2020-02-25
JohnPac	2020-03-13

ANNEX II: 2020 STUDY OF FOOD AID

From June 2020 to August 2020, the team remotely gathered information from U.S. and internationally based stakeholders by deploying short surveys to the following stakeholders—shipping and handling contractors; USAID/BHA partners (PVOs, PIOs, and service contractors), USAID/BHA personnel, and other USG representatives, and commodity and packaging suppliers. These surveys included customized questions associated with each stakeholder's role in the supply chain. In total, there were 67 survey responses. Twenty-seven responses came from the USG, representing over 40 percent of respondents. This was followed by commodity suppliers (18 percent), international PVO/PIO/NGOs (15 percent), and transportation/shipping organizations (6 percent) including freight forwarders (Figure 15). Local PVO/NGOs and warehouse operations accounted for the smallest share of responses at 3 percent and 6 percent, respectively.

Figure 17: QR Code Deliverables for Cycle



"We operate in areas of minimal internet connectivity so if we use this then there should be a way to upload data with minimal need to get online."

- International PVO/PIO/NGO Representative

Although most respondents had some familiarity with QR codes, local representatives from PVO/PIO/NGOs were not too familiar with the QR code technology (Figure 16). When asked about the potential challenges of integrating the QR code technology into the food aid supply chain, the most common responses were related to Internet connectivity, consistent IT standards and use across the supply chain, and the lead times and costs associated with adding QR codes to commodity packaging. In terms of the potential benefits, many respondents mentioned the benefits of increased data visibility and coordination, as well as improved commodity tracking and traceability.

Figure 18: QR Code Familiarity

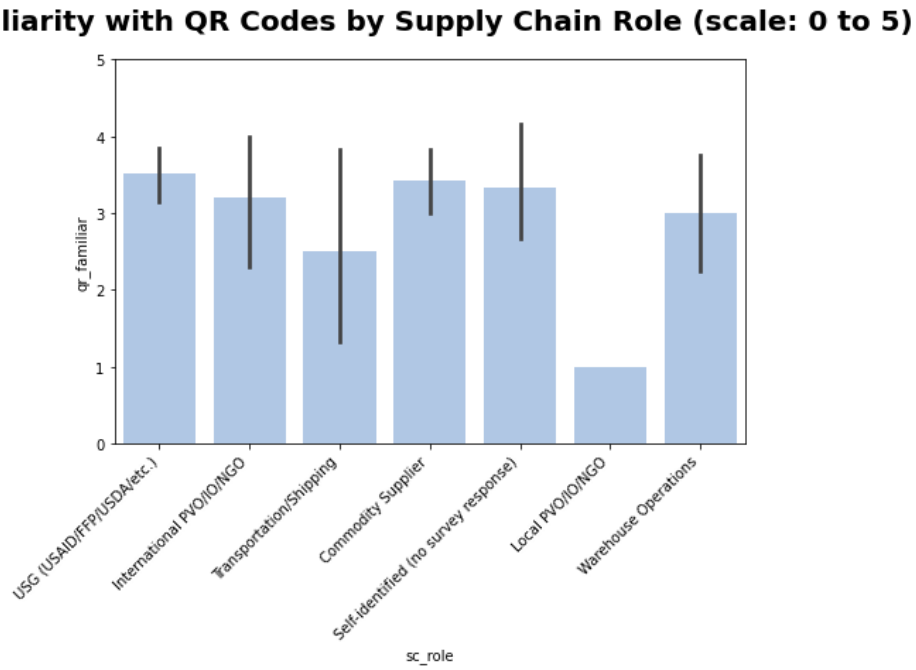
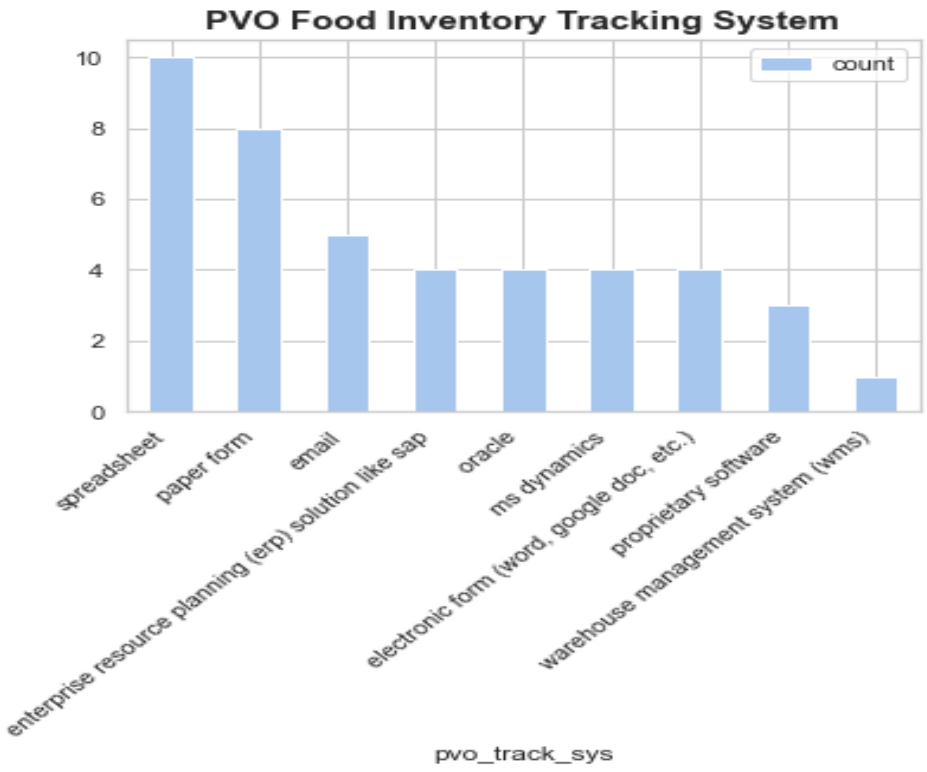


Figure 19: QR Code Opportunities – Word Cloud

"My organization is engaging in the implementation of an ERP; as such QR code is unique opportunity to integrate high level technology and complement innovations in the supply chain management."

- International PVO/PIO/NGO Representative

Figure 20: Existing PVO/PIO/NGO Data Sharing



When asked what systems are used to keep track of food aid inventory in warehouses, most respondents said they used spreadsheets, paper forms, email, and proprietary software. Figure 18, for example, shows how PVOs, PIOs, and NGOs reported how they tracked food aid inventories. Similar responses were provided for food aid data tracking when commodities are shipped or distributed to beneficiaries. A little over half of PVO, PIO, and NGO respondents said their organizations currently have the capability to use QR codes, while the other half either said they did not have the capability or did not know if they had the capability. Nine out of 12 (75 percent) international and local representatives from PVOs, PIOs, and NGOs said they completely agreed or somewhat agreed when asked whether QR codes would help reduce total food aid losses (Figure 19). Approximately 42 percent of respondents did not know what the total estimated time is for recalling food aid, while 25 percent said it was more than 4 weeks and the remaining respondents said it was either less than 24 hours or between 3 and 7 days.

Figure 21: QR Codes and PVO/PIO/NGO Losses

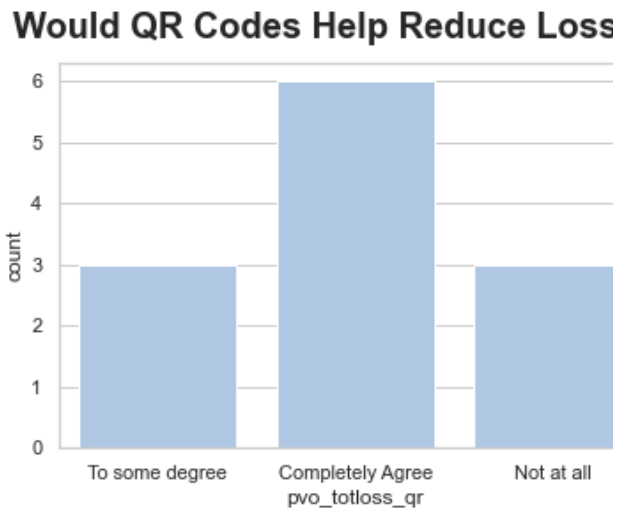
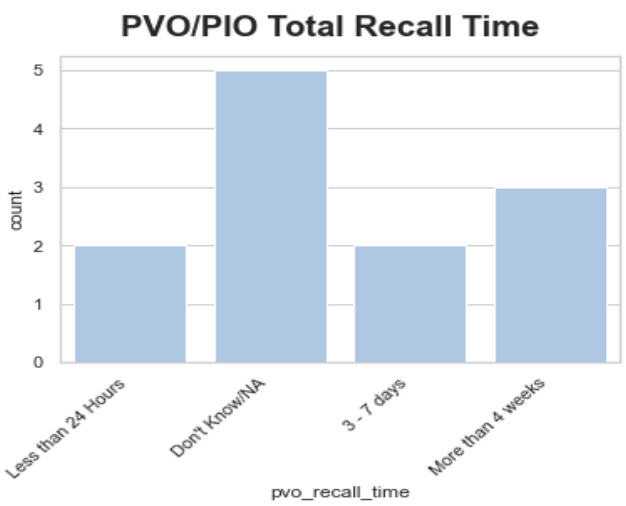


Figure 22: PVO/PIO/NGO Total Recall Times



"Printing QR codes on food packaging is critical for USAID to maintain traceability, and we fully support this initiative. It would allow us to have quicker access to problems in the field and be able to respond in a more timely manner. The level of investment (namely in printers) will depend on the solution that USAID chooses and the level of detail the QR code can include."

- Supplier

"The type of packaging typically used isn't well suited for printing as or after filling. A change in packaging material may be required, increasing unit pricing and possibly lead times."

- Supplier

Nine out of 12 (75 percent) of suppliers said they did not currently have the capacity to print QR codes or did not know if they had the capacity to print QR codes (Figure 21). This compares to only 2 out 12 suppliers who said they are currently capable of printing QR codes. At the same time, eight out of 12 (66 percent) of suppliers said that it was possible to print QR codes (Figure 22). In interviews with many non-PP bag suppliers, the incremental investments needed to print QR codes includes printers, print cartridges, and small adjustments to existing procedures and processes. Suppliers using PP bags all said there would need to be adjustments to the existing packaging material to add QR codes.

Figure 23: Capacity to Print QR Codes

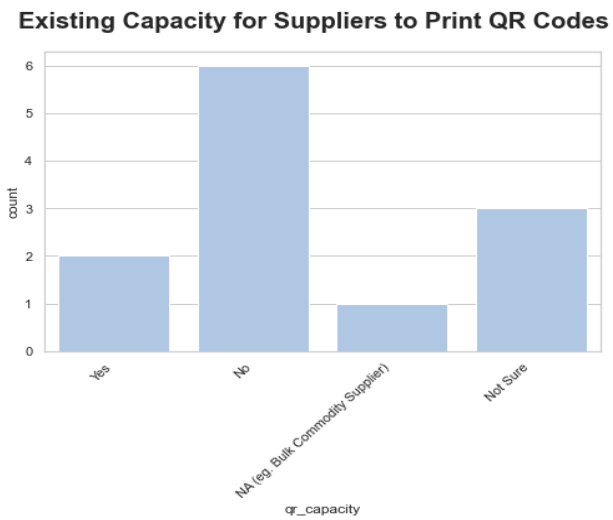
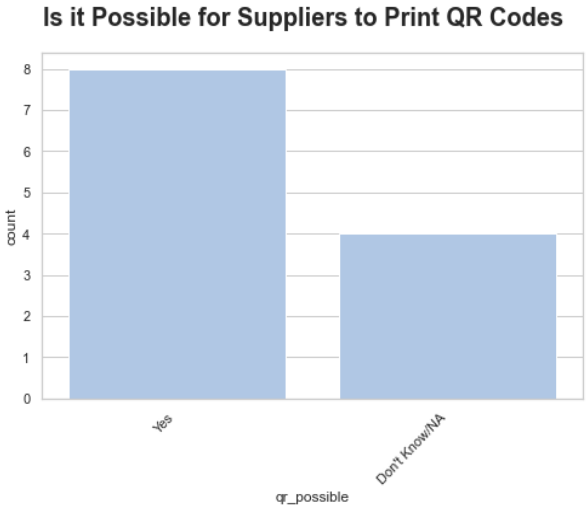


Figure 24: Potential to Print QR Code



A majority (50 percent) of USG officials reported that they receive food aid data reports on monthly or quarterly basis (Figure 23). This compares to around 27 percent of USG respondents who receive food aid data updates on a weekly basis. Sixteen out of 25 respondents (64 percent) of USG officials said they did not have the right level of data to 'excel' at their jobs, compared to 5 out of 25 respondents (20 percent) who said they had the appropriate amount of information (Figure 24).

Figure 25: Food Aid Data – Reporting Intervals

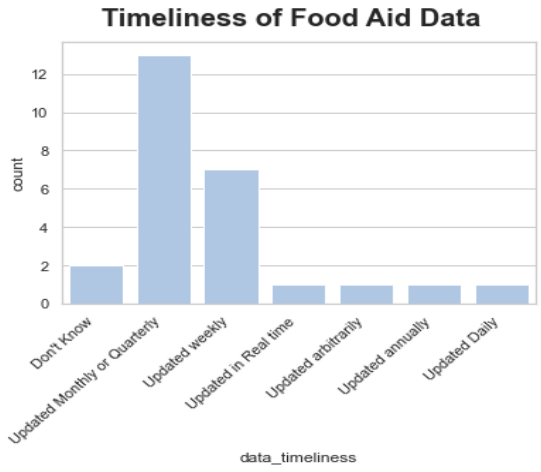
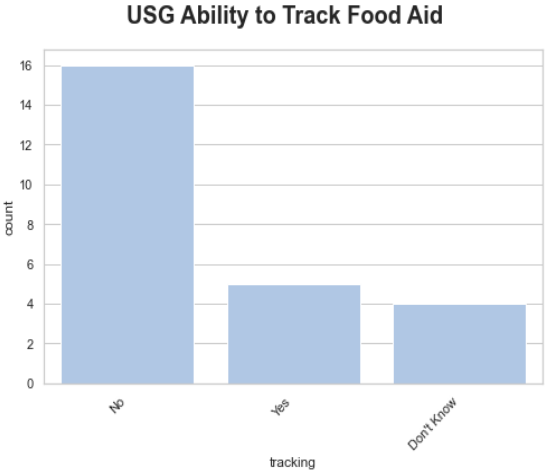


Figure 26: Tracking and Job Performance



ANNEX III: 2020 STUDY OF FOOD AID SURVEY

2020 Study of Food Aid

* Required

The following survey has been designed to help the USAID food aid program gather data for an ongoing study on the feasibility of adding QR codes to food aid packaging to improve accountability and ultimately improve the amount of food that can be provided to hungry people. This survey is meant to take roughly 15-20 minutes to complete and can be completed in part or in full as you are able. All data collected will be kept anonymous and only reported in aggregate, with all identifying information of people or organizations removed. We appreciate you sharing your time and information with us. If you have any questions or concerns, please contact our survey team lead (nathan.martinez@limestone-analytics.com).

Consent for Data Collection

1. Do you consent to sharing your data, for use exclusively in our analysis? *

   All data collected will be accessible only to the third party research team, and only reported in aggregate, with all identifying information of people or organizations removed.

   Mark only one oval.

   - ◯ No
   - ◯ Yes

Intro - All Stakeholders

2. Please provide your name.

   _____

3. What's your email

   _____

4. What organization/office are you representing?

   If you work for an office within a larger organization, please list both the organization and the office.

   _____

5. What is your current position within this organization?

   _____

6. What country do you do the majority of your work in?

   If your work is relevant to a region or multiple countries, please select one about which you feel knowledgeable, and answer the survey questions as applicable to that country.

   _____

7. How large is your organization (# of Employees)

Mark only one oval.

- ◯ 1-20 employees
- ◯ 21-100 employees
- ◯ 100-500 employees
- ◯ 500+ employees

8. What role does your organization/office play in the USAID-FFP supply chain? *

This question will define the questions asked in the remaining portion of the survey. If you are unsure which category you belong to, feel free to contact our team and discuss.

Mark only one oval.

- ◯ International PVO/IO/NGO *Skip to question 9*
- ◯ Local PVO/IO/NGO *Skip to question 9*
- ◯ Warehouse Operations *Skip to question 39*
- ◯ Transportation/Shipping *Skip to question 70*
- ◯ USG (USAID/FFP/USDA/etc.) *Skip to question 91*
- ◯ Commodity Supplier *Skip to question 28*
- ◯ Other: _____

Skip to question 102

PVO and Implementing Partners

9. Which of the following commodities does your organization distribute? Please select all that you are familiar with:

Check all that apply.

- ☐ Beans
- ☐ Bulgur
- ☐ Cereals
- ☐ Corn Soy Blend
- ☐ Corn
- ☐ Emergency Food Supplements (RUTF & RUSF)
- ☐ Flour
- ☐ High Energy Biscuits
- ☐ Oil
- ☐ Peas
- ☐ Pulses
- ☐ Rice
- ☐ Sorghum
- ☐ Wheat

Other: ☐ _____

10. How many beneficiaries does your organization provide food aid to in your country, on average in a year?

We are hoping to get a general sense of the size of your organization, and the number of beneficiaries you help in the relevant country. This beneficiary number can be compared across countries to warehousing and distribution sites to better understand density.

_____

11. How many food aid distribution sites does your organization operate directly, in your country?

How many locations do you distribute food to beneficiaries from? For example, if all food in one country is distributed in one specific refugee camp, you could say 1. If you have multiple distribution sites across a country, you would estimate the number of different sites. Estimates are OK.

_____

12. How many warehouses are part of your organization's supply chain in your country?

How many warehouses do you store food aid before its distributed. These warehouses can be owned or managed by your organization, contracted to another company, or shared with another PVO organization.

_____

13. How much warehouse space (in Sq. ft) does your organization use in your country?

How much space do you utilize for storing food. This would be the estimated total floor space across all warehouses you manage, own or contract from other parties.

Mark only one oval.

- ◯ <10,000 Sq Feet
- ◯ 10,001 - 25,000 Sq Feet
- ◯ 25,001 - 50,000 Sq Feet
- ◯ 50,001 - 100,000 Sq Feet
- ◯ 100,001 - 200,000 Sq Feet
- ◯ 200,001 - 500,000 Sq Feet
- ◯ > 500,000 Sq Feet

14. What systems do you use to keep track of food aid inventory in warehouses?

We wish to learn about how data is collected, managed and shared currently by our partners to assess the current capabilities and capacity for additional data tools. Please select all that apply:

Check all that apply.

- ☐ Spreadsheet
- ☐ Paper Form
- ☐ Electronic Form (Word, Google Doc, Etc.)
- ☐ Email
- ☐ Enterprise Resource Planning (ERP) Solution like SAP, Oracle, MS Dynamics, etc.
- ☐ Warehouse Management System (WMS)
- ☐ Proprietary Software
- Other: ☐ _____

15. What systems do you use to track food aid shipments? Please select all that apply:

Check all that apply.

- [ ] Spreadsheet
- [ ] Paper Form
- [ ] Electronic Form (Word, Google Doc, Etc.)
- [ ] Email
- [ ] ERP
- [ ] WMS
- [ ] Proprietary Software

Other: [ ]

16. What systems do you use to track food aid data on distributions? Please select all that apply:

Check all that apply.

- [ ] Spreadsheet
- [ ] Paper Form
- [ ] Electronic Form (Word, Google Doc, Etc.)
- [ ] Email
- [ ] ERP
- [ ] WMS
- [ ] Proprietary Software

Other: [ ]

17. What is the most granular unit/grouping that commodities you store can be differentiated and traced by?

For example, in the case of a potential recall where a product may have a defect, could you recall all similar items from that batch? Alternatively, you may only have labeling by PO# and might have to assume that all commodities from the same PO # potentially suffered from the same defect. In this question, we are attempting to gather information from different organizations about what level of granularity data is currently stored and tracked in their respective systems.

Mark only one oval.

- ◯ Individual Commodity (Bag/Can/Pouch/Etc.)
- ◯ Lot
- ◯ Batch
- ◯ USAID / USDA PO #
- ◯ Other:

18. How long after a shipment is received or shipped is data updated in one of your systems?

Mark only one oval.

- ◯ Immediately (Real-time)
- ◯ Within a day
- ◯ Within a week
- ◯ More than a week later
- ◯ More than 2 Weeks
- ◯ More than a Month
- ◯ NA

19. Do any of your warehouses have barcode scanning equipment (handheld scanners, conveyor belt scanning, etc)?
Is it possible to scan the food aid coming into the warehouse?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know
- ◯ NA

20. Do any of your warehouses use barcodes technology to manage inventory within their operations?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know

21. Could your organization use barcode scanning at distribution sites (handheld scanners, mobile phones, etc)?
Do you think you can use barcode technology to update your system inventory on real time basis as you distribute food aid at distribution points?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know
- ◯ NA

22. On average, how often do you witness, or are you impacted by, human errors in data entry?

Mark only one oval.

- Daily
- Weekly
- Monthly
- Very infrequently (less than once a month)
- Don't Know/NA

23. Can you estimate the percentage of food that is lost between procurement and distribution from the following sources:

Mark only one oval per row.

	<0.5%	0.5 - 1%	1 - 2%	2 - 5%	5-10%	10-20%	>20%	NA
Total Losses								
Humidity								
Pests								
Faulty Packaging								
Freight/Shipping Mishandling								
Inventory Surpasses Expiration Date								
'Short' Deliveries								
Theft								

24. Would the adoption of a food aid tracking system help in reducing the previously mentioned sources of loss or inefficiencies in supply chain?

Mark only one oval per row.

	Completely Agree	To some degree	Not at all	Don't Know/NA
Total Losses (All Sources)				
Humidity				
Pests				
Faulty Packaging				
Freight/Shipping Mishandling				
Inventory Surpasses Expiration Date				
'Short' Deliveries				
Theft				

25. Has your organization required commodities to be recalled in the last 12 months?

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 102*
- ◯ Don't Know/NA *Skip to question 102*

26. If so, was currently available data sufficient for efficiently managing this process?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know/NA

27. On average, how long does a recall take (from the point where a recall is issued, to the point where all commodities that are targeted are located)?

Mark only one oval.

- ◯ Less than 24 Hours
- ◯ 1 - 2 days
- ◯ 3 - 7 days
- ◯ 1 - 4 weeks
- ◯ More than 4 weeks
- ◯ Don't Know/NA

Skip to question 102

Commodity Suppliers

28. What category of food or commodity do you supply for USAID-Food For Peace Program? Please select all that apply.

Check all that apply.

- ☐ Packaging Material
- ☐ Bulk Commodity
- ☐ Packaged Commodity in Paper or Hybrid Bags
- ☐ Packaged Commodity in Cans
- ☐ Packaged Commodity in Cartons

Other: ☐ _____

29. Which of the following commodities do you supply under USAID-FFP Program? Please select all that apply.

Check all that apply.

- [ ] Beans
- [ ] Bulgur
- [ ] Cereal
- [ ] Corn Soy Blend
- [ ] Corn
- [ ] Emergency Food Supplements
- [ ] Flour
- [ ] Oil
- [ ] Peas
- [ ] Pulses
- [ ] Rice
- [ ] Sorghum
- [ ] Wheat

Other: [ ] _____

30. Please estimate the annual volume of commodities you supply under USAID-FFP Program.

Mark only one oval.

- ◯ <10,000 MT
- ◯ 10,001 - 20,000 MT
- ◯ 20,001 - 30,000 MT
- ◯ 30,001 - 50000 MT
- ◯ 50,001 - 100,000 MT
- ◯ 100,001 - 250,000 MT
- ◯ >250,000 MT

31. Do you have experience in printing barcodes on any of your food commodities for any customer?

Mark only one oval.

- ◯ Yes
- ◯ No

32. Is QR code labeling on FFP commodities you supply something you think is possible?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know/NA

33. Would it be possible for you to print a QR code on the packaging for your commodity with your existing printers and technology capabilities?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not Sure
- ◯ NA (eg. Bulk Commodity Supplier)

34. If No, what do you estimate it would cost for you to upgrade your printing / technology capability so that QR codes can be printed?

Mark only one oval.

- ◯ <$10,000 USD
- ◯ $10,001 - $20,000 USD
- ◯ $20,001 - $30,000 USD
- ◯ $30,001 - $40,000 USD
- ◯ $40,001 - $50,000 USD
- ◯ Don't Know
- ◯ NA

35. What would be the estimated additional marginal cost per item be for you to print QR codes on your product?

Mark only one oval.

- ◯ <0.01 USD per unit
- ◯ 0.01-0.05 USD per unit
- ◯ 0.05-0.10 USD per unit
- ◯ >0.10 USD per unit
- ◯ Don't Know
- ◯ NA

36. Would adding QR codes change your lead times?

Mark only one oval.

- ◯ Lead times would likely not increase
- ◯ Lead times would likely increase by few days
- ◯ Lead times would likely increase by few weeks or more
- ◯ Don't Know
- ◯ N/A

37. Would a requirement to print QR Codes on all commodities for FFP affect your willingness to bid on procurement contracts?

Mark only one oval.

- ◯ Yes, would be less likely to bid on contracts
- ◯ No, will not change willingness to bid on contracts
- ◯ Unsure/depends on circumstances

38. Please expand on why printing QR codes on all food packaging would be useful or not. What challenges do you anticipate? Can these be overcome?

_____

_____

_____

_____

_____

Skip to question 102

Warehouse / Supply Chain Operations

39. How many warehouses do you operate in your country?

For the purposes of this survey, we would like responses to remain relevant to the country you do the majority of your work in, as reported in the intro section.

_____

40. Please share your average warehouse size in Sq. Feet:

Mark only one oval.

- ◯ <10,000 sq ft
- ◯ 10,001-25000 sq ft
- ◯ 25,001 - 50,000 sq ft
- ◯ 50,001-100,000 sq ft
- ◯ 100,001-200,000 sq ft
- ◯ 200,001-500,000 sq ft
- ◯ > 500,000 sq ft
- ◯ Don't Know/NA

41. Please share your average warehouse storage capecity in Metric Tons:

Mark only one oval.

- ◯ <1,000 MT
- ◯ 1,001-2,500 MT
- ◯ 2,501-5,000 MT
- ◯ 5,001-10,000 MT
- ◯ >10,000 MT
- ◯ NA

42. Which organizations do you work with in connection with USAID Food Supply Chain? Please select all that apply.

Check all that apply.

- ☐ USAID
- ☐ United Nations (WFP, UNICEF, etc.)
- ☐ Catholic Relief Services
- ☐ Relief Society Of Tigrey
- ☐ World Vision, Inc.
- ☐ Food For The Hungry, Inc.
- ☐ Cooperative For Assistance And Relief
- ☐ Save The Children Federation, Inc.
- ☐ Helen Keller International Inc
- ☐ Mercy Corps
- ☐ Other

43. What is the estimated average quantity (in Metric Tons) of food aid commodities that you store across all your warehouses on a monthly basis?

Mark only one oval.

- ◯ <1,000 MT
- ◯ 1,001 - 5,000 MT
- ◯ 5,001 - 10,000 MT
- ◯ 10,001 - 25,000 MT
- ◯ 25,001 - 50,000 MT
- ◯ >50,001 - 100,000 MT
- ◯ >100,000 MT

44. Please select which of the following methods you use to store the food aid commodities in your warehouse:

Check all that apply.

- ☐ Stacked
- ☐ Food Aid Packaged in Pallets
- ☐ Racks

Other: ☐ _____

45. Please check all peckaging types that have been handled in the past year in your operations:

Check all that apply.

- [ ] Polypropylene (PP) Bags
- [ ] Paper Bags
- [ ] Hybrid Paper Bags
- [ ] Cans
- [ ] Cartons/Boxes
- [ ] Food Packaged on Pallets, e.g. Pallets of Oil Cans or Boxes of Emergency Food Supplements

Other: [ ] _____

46. Which of the following warehouse activities are performed on the food aid commodities that are stored in your warehouses? Please select all that apply.

Check all that apply.

- [ ] Stock movement / consolidation within warehouse,
- [ ] Repackaging
- [ ] Reconditioning
- [ ] Fumigation
- [ ] Spraying

Other: [ ] _____

47. On average, across all of your warehouses, how many new incoming food aid shipments do you receive in a month?

Note: One Shipment is equal to a single batch of food aid coming to the warehouse, e.g. one or more trucks, rail car(s) from a single PO or Ocean bill of lading or Way Bill

Mark only one oval.

- ◯ 0 - 5
- ◯ 6 - 10
- ◯ 11 - 20
- ◯ 21 - 30
- ◯ 31 - 40
- ◯ 40+

48. On average how many different food aid commodities types are received together in each new incoming shipment?

Mark only one oval.

- ◯ 1
- ◯ 2 - 4
- ◯ >5

49. What is the average size of the inbound shipment in Metric Tons

50. How is each food aid commodity shipment identified and tracked within the warehouse? Please check all that apply.

Check all that apply.

- [ ] USDA/USAID PO #
- [ ] Contract #
- [ ] Lot #
- [ ] Unique ID
- [ ] Other:

51. On average, across all of your warehouses, how many new outbound food aid shipments do you ship in a month?

Note: One Shipment is equal to a single batch of food aid shipped from the warehouse, e.g. one truck, rail car(s) or multiple trucks on a single Land or Ocean Bill of Lading

Mark only one oval.

- ◯ <5
- ◯ 6 - 10
- ◯ 11 - 20
- ◯ 21 - 30
- ◯ 31 - 40
- ◯ >40
- ◯ NA

52. What is the average size of the outbound shipment in Metric Tons

53. On average how many different food aid commodities types are shipped together in each outbound shipment?

Mark only one oval.

- ◯ 1
- ◯ 2 - 4
- ◯ >5

54. Please select the names of the food aid organizations that you ship your food aid commodities to

Check all that apply.

- [ ] United Nations (Unicef/WFP, Etc.)
- [ ] Catholic Relief Services
- [ ] Relief Society Of Tigrey
- [ ] World Vision, Inc.
- [ ] Food For The Hungry, Inc.
- [ ] Cooperative For Assistance And Relief
- [ ] Save The Children Federation, Inc.
- [ ] Helen Keller International Inc
- [ ] Mercy Corps
- [ ] Other: _____

55. Where do you typically ship these commodities? Please select all that apply.

Check all that apply.

- [ ] Ports
- [ ] Regional warehouse
- [ ] Food aid distribution points
- [ ] Other: _____

56. Can you estimate the percentage of food that is lost between procurement and distribution from the following sources:

Mark only one oval per row.

	<0.5%	0.5-1%	1-2%	2-5%	5-10%	10-20%	>20%
Total Losses	◯	◯	◯	◯	◯	◯	◯
Humidity	◯	◯	◯	◯	◯	◯	◯
Pests	◯	◯	◯	◯	◯	◯	◯
Faulty packaging	◯	◯	◯	◯	◯	◯	◯
Shipping and handling	◯	◯	◯	◯	◯	◯	◯
Exceeded Expiration Date	◯	◯	◯	◯	◯	◯	◯
"Short" Delivery	◯	◯	◯	◯	◯	◯	◯
Theft	◯	◯	◯	◯	◯	◯	◯

57. Would the adoption of a commodity tracking system reduce the previously mentioned sources of loss (or inefficiency)?

Mark only one oval per row.

	Completely	To some degree	Not at all	Unsure/NA
Total Losses	◯	◯	◯	◯
Humidity	◯	◯	◯	◯
Pests	◯	◯	◯	◯
Faulty packaging	◯	◯	◯	◯
Shipping and handling	◯	◯	◯	◯
Exceeded Expiration Date	◯	◯	◯	◯
"Short" Delivery	◯	◯	◯	◯
Theft	◯	◯	◯	◯

58. Please share the type(s) of warehouse and inventory management systems that are used to manage warehouse operations in your organization?

Check all that apply.

- ☐ In-house developed System
- ☐ Commercially bought Systems
- ☐ Excel
- ☐ Paper

Other: ☐ _____

59. Please share how does your organization share data and reports with your customers and stakeholders like USAID, WFP, WV, etc.

Check all that apply.

- ☐ Reports from In-house System,
- ☐ Reports from Commercially bought Systems
- ☐ Excels
- ☐ PDFs
- ☐ Electronic Data Interchange with your customer (EDI, API, etc.)

Other: ☐ _____

60. On average, how much time is spent collecting and entering data for each inbound or outbound shipment?

Mark only one oval.

- < 15 mins
- 15 -30 mins
- 31 - 60 mins
- 60 - 120 mins
- > 120 mins

61. On average how many days are taken to report each inbound or outbound shipment to your customer?

Mark only one oval.

- 1 - 3 Days
- 4 - 7 Days
- 1 - 2 Weeks
- 2 - 4 Weeks
- > 4 Weeks

62. On average, how much time does it take staff to update your information systems after the inventory-related activity is performed on existing inventory within your warehouse (e.g. stock movement, repackaging, fumigation, etc)

Mark only one oval.

- <15 mins
- 15 -30 mins
- 31 - 60 mins
- 60 - 120 mins
- > 120 mins

63. On average, how much time is spent creating each customer report?

Mark only one oval.

- <15 mins,
- 15 -30 mins
- 31 - 60 mins
- 60 - 120 mins
- > 120 mins

64. On average how many days / weeks are taken to report on activities performed on food aid commodities to your customer?

Mark only one oval.

- ◯ 1 - 3 Days
- ◯ 4 - 7 Days
- ◯ 1 - 2 Weeks
- ◯ 2 - 4 Weeks
- ◯ > 4 Weeks

65. How do you share reports and or data with your customer (e.g. Excel, forms, email, etc)?

Check all that apply.

- ☐ Spreadsheet
- ☐ Paper Form(s)
- ☐ Digital Form (Word file/Google doc/ etc.)
- ☐ Email
- ☐ ERP
- ☐ WMS
- ☐ Proprietary Software

Other: ☐ _____

66. Do you utilize bar code scanning capabilities in your current warehouse operations?

Mark only one oval.

- ◯ Yes
- ◯ No

67. Do you have bar code scanning capabilities that can be utilized in your warehouse operations?

Mark only one oval.

- ◯ No
- ◯ Yes
- ◯ Don't Know

68. If NO, Have you ever looked into adding scanning capabilities for your warehouse operations?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ NA

69. If yes, how do you use barcoding in your warehouse operations?

Skip to question 102

Transportation

70. Please tell us the various transportation modes your organization deals in?

Check all that apply.

- [ ] Ocean (Bulk)
- [ ] Flatbed Trucks with Containers
- [ ] Trucks
- [ ] Rail
- [ ] Multi-Modal
- [ ] Other

71. Which organizations do you work with, in connection with USAID Food Supply Chain? Please select all that apply.

Check all that apply.

- [ ] United Nations
- [ ] Catholic Relief Services
- [ ] Relief Society Of Tigrey
- [ ] World Vision, Inc.
- [ ] Food For The Hungry, Inc.
- [ ] Cooperative For Assistance And Relief
- [ ] Save The Children Federation Inc.
- [ ] Helen Keller International Inc
- [ ] Mercy Corps

Other: [ ] _____

72. What is the estimated average quantity (in Metric Tons) of food aid commodities that you transport on a monthly basis?

Mark only one oval.

- <1,000 MT
- 1,001 - 2,500 MT
- 2,501 - 10,000 MT
- 10,001 - 20,000 MT
- 20,001 - 30,000 MT
- 30,001 - 50,000 MT
- >50,000 MT

73. Which packaging types that you have handled in the past year? Please select all that apply.

Check all that apply.

- [ ] Polypropylene (PP) Bags
- [ ] Hybrid Paper Bags
- [ ] Cans
- [ ] Boxes / Cartons
- [ ] Palletized Cargo

74. Which transportation packing/stuffing, storage methods do you use to move food aid commodities? Please select all that apply.

Check all that apply.

- [ ] Stacked
- [ ] Food Aid Packaged in Pallets
- [ ] Racks

Other: [ ] _____

75. Which transportation routes/shipping lanes do you use? Please select all that apply.

Check all that apply.

- [ ] Port to Central Warehouse - Container Cargo on Flat Beds
- [ ] Port to Central Warehouse - Non Container Cargo
- [ ] Central Warehouse to Regional Warehouses
- [ ] Central Warehouse to Aid Distribution Points,
- [ ] Regional Warehouses to Aid Distribution Points

76. On average, how many food aid shipments do you handle in a month?

Note: One Shipment is equal to a single batch of food aid transported into or out of the warehouse, e.g. one or multiple trucks in one customer order

Mark only one oval.

- 0 - 5
- 6 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 40+

77. What is the size of an average shipment in Metric Tons?

Mark only one oval.

- > 10 MT
- 11 - 25 MT
- 26 - 50 MT
- 51 - 100 MT
- 101 - 200 MT
- 201 - 350 MT
- 351 - 500 MT
- 501 - 1,000 MT
- 1,001 - 2,000 MT
- 2,001 - 3,000 MT
- 3,001 - 5,000 MT
- 5,001 - 10,000 MT
- 10,001 - 20,000 MT
- >20,000 MT

78. How is each food aid commodity shipment identified, tracked and managed within your organization? Please select all that apply.

Check all that apply.

- [ ] USDA / USAID PO #
- [ ] Contract #
- [ ] Lot #
- [ ] Unique ID
- [ ] Other: _____

79. Can you estimate the percentage of food aid that is lost during loading, transit and unloading process from the following sources:

Mark only one oval per row.

	<0.5%	0.5-1%	1-2%	2-5%	5-10%	10-20%	>20%	NA
Total Loss (All sources)	◯	◯	◯	◯	◯	◯	◯	◯
Humidity	◯	◯	◯	◯	◯	◯	◯	◯
Pests	◯	◯	◯	◯	◯	◯	◯	◯
Faulty Packaging	◯	◯	◯	◯	◯	◯	◯	◯
Loading, Unloading and Handling	◯	◯	◯	◯	◯	◯	◯	◯
Theft	◯	◯	◯	◯	◯	◯	◯	◯

80. Would the adoption of a commodity tracking system reduce the previously mentioned sources of loss (or inefficiency)?

Mark only one oval per row.

	Completely	To some degree	Not at all	Unsure/NA
Total Loss (All sources)	◯	◯	◯	◯
Faulty Packaging	◯	◯	◯	◯
Loading, Unloading and Handling	◯	◯	◯	◯
Theft	◯	◯	◯	◯

81. Which of the following sources of loss could be reduced if improved data were available (for example due to QR code scanning)? Please check all that apply.

Check all that apply.

- ☐ Faulty Packaging
- ☐ Shipping and Handling
- ☐ Best Buy Use Date
- ☐ Exceeded Expiration Date
- ☐ "Short" Delivery
- ☐ Theft

82. Please share the type(s) of transportation management systems used to manage your operations? Check all that apply.

Check all that apply.

- [ ] "In house"/Proprietary System
- [ ] Commercially bought Systems
- [ ] Excel
- [ ] Paper
- [ ] Other: _____

83. Please share how does your organization receive customer orders and share data and reports with your customers and stakeholders (like USAID, WFP, WV, etc.)

Mark only one oval.

- ◯ Reports generated from "In house"/Proprietary system
- ◯ Reports from Commercially bought Systems
- ◯ Excel
- ◯ PDFs
- ◯ Electronic Data Interchange with your customer (EDI, API, etc.)
- ◯ Other: _____

84. On average, how much time is spent to update data in your system after a shipment is processed?

Mark only one oval.

- ◯ <15 mins
- ◯ 16 -30 mins
- ◯ 31 - 60 mins
- ◯ 60 - 120 mins
- ◯ > 120 mins

85. On average how many days are taken to report each shipment to your customer?

Mark only one oval.

- ◯ 1 - 3 Days
- ◯ 4 - 7 Days
- ◯ 1 - 2 Weeks
- ◯ 2 - 4 Weeks
- ◯ > 4 Weeks

86. On average, how much time is spent creating each customer report?

Mark only one oval.

- <15 mins
- 16 -30 mins
- 31 - 60 mins
- 60 - 120 mins
- > 120 mins

87. Do you use bar code scanning capabilities in your current operations?

Mark only one oval.

- Yes
- No
- Don't Know

88. Do you have bar code scanning capabilities that can be used in your operations?

Mark only one oval.

- Yes
- No
- Don't Know/NA

89. If NO, Have you ever looked into adding scanning capabilities for your operations?

Mark only one oval.

- Yes
- No

90. If yes, how do you use barcoding in your operations?

Skip to question 102

USG (USAID and USDA)

91. On a scale from 1-5, with 5 being very important, and 1 being not very important, how important is the ability to access high-quality data to your work?

Mark only one oval.

	1	2	3	4	5	
Not Very Important	◯	◯	◯	◯	◯	Very Important

92. What data sources do you currently have access to in your position:

Check all that apply.

- [ ] Procurement Documents
- [ ] Shipping/Freight Contracts
- [ ] Delivery Reports
- [ ] Warehouse Inventory
- [ ] In Country Shipping Data
- [ ] Distribution Data

Other: [ ] _____

93. How up to date is the data you typically use for your job

Mark only one oval.

- ◯ Updated in Real time
- ◯ Updated Daily
- ◯ Updated weekly
- ◯ Updated Monthly or Quarterly
- ◯ Updated annually
- ◯ Updated arbitrarily
- ◯ Don't Know
- ◯ NA

94. Is your ability to track food aid currently at a level that you feel is sufficient for you to excel in your work?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know
- ◯ NA

95. Would real-time visibility of commodities in the food aid supply chain improve your work?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't Know
- ◯ NA

96. Please explain how real-time data visibility would improve/affect the work you do.

97. Please rate data visibility (from your perspective) for the following points in the supply chain?

Mark only one oval per row.

	No Data available	Some data available	Ample data available	NA/Don't Know
Procurement	◯	◯	◯	◯
International Shipping	◯	◯	◯	◯
Discharge Ports	◯	◯	◯	◯
Warehouse Inventory Tracking and Traceability	◯	◯	◯	◯
Aid country food movement	◯	◯	◯	◯
Point of distribution	◯	◯	◯	◯

98. Please check up to three points where improved data visibility could have the greatest impact:

Check all that apply.

- ☐ Procurement
- ☐ International Shipping
- ☐ Discharge Ports
- ☐ Warehouse Inventory Tracking and Traceability
- ☐ Aid country food movement
- ☐ Point of distribution

99. Has your organization been involved in a commodity recall in the last 6 months?

Mark only one oval.

- Yes
- No
- Don't Know
- NA

100. If so, was currently available data sufficient for efficiently managing this process?

Mark only one oval.

- Yes
- No
- Don't Know
- NA

101. On average, how long does a recall take (from the point where a recall is issued to the point where all commodities that are targeted are located)?

Mark only one oval.

- less than 24 Hours
- 1-2 days
- 3 -7 days
- 1-4 weeks
- More than 4 weeks
- NA

Skip to question 102

Closing Questions

102. How familiar are you with QR codes?

Mark only one oval.

	1	2	3	4	5	
Not Familiar	◯	◯	◯	◯	◯	Very Familiar

103. Have you ever scanned a QR code with your phone?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not Sure/Don't Remember

104. Do you believe decision-makers in your organization have access to a sufficient amount of accurate, up to date data to make well-informed decisions?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not Sure/Don't Know

105. What opportunities do you anticipate if your organization were to integrate the QR code technology into the food aid supply chain?

106. What challenges do you anticipate if your organization were to integrate the QR code technology into the food aid supply chain?

107. Would you be willing/able to share any of the following documents/data-sources with our team to help us identify opportunities to improve USAID food aid supply chain?

Documents could be submitted anonymously with identifying information removed.

Check all that apply.

- [ ] Procurement orders
- [ ] Shipping records
- [ ] Warehouse contracts
- [ ] Warehouse inventory snapshots
- [ ] Existing IT system descriptions
- [ ] Distribution records
- [ ] Incident reports
- [ ] Spreadsheets
- [ ] Other: _____

108. Would you be willing to participate in a short follow up discussion with the study team if they have any further questions, or require clarification?

Mark only one oval.

- ◯ Yes
- ◯ No

Thank you for your participation.

ANNEX IV: REFERENCES

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ANNEX V. COST-BENEFIT MODEL

To understand if the proposed QR implementation is economically feasible, the team has constructed an economic model that allows the comparison of costs and benefits in the current system and the proposed future system.

This CBA is applied to two major items that would be part of a potential solution. The first is the actual printing of QR codes on food commodities, which would allow for the rapid identification of items in overseas warehouses via scanners, tablets, or mobile phones. This would require relatively minor investments in designing a specification and may add small marginal costs to the cost of packaging for commodities procured. The result of this small change would be an improved ability to trace commodities in the supply chain, such as when a recall is underway. QR codes could hold more information than is currently available from packaging, such as the manufacturer, the batch number, the status of the commodity, etc. However, simply printing QR codes alone will not achieve the greater goal of real-time end-to-end data visibility. They would, however, create a foundation on which our send item can be built.

The second item we are considering is a data collection system that is implemented throughout the food aid supply chain to allow for the tracking of commodities from procurement, through shipping and warehousing, and finally to the site where commodities are delivered to beneficiaries. This system would be complex to implement and require the coordination of numerous actors around the world. The system would require significant investment in information technology, and would add ongoing costs for system upkeep, and may add costs to the actors in the supply chain who would be expected to use it, such as warehouses, shipping companies, and PVOs. Despite these costs, the benefits of this system (primarily end-to-end visibility) have the potential to offset them. If the billions of dollars in aid that flows through the supply chain can now be tracked and traced effectively, small issues can be addressed. When dealing with billions of dollars in aid, even a minor improvement to overall efficiency rates can be worth the investment in data collection many times over.

BENEFIT 1 - REDUCTION IN COMMODITIES LOST

The proposed AIDC/QR code solution could help reduce commodity loss in the BHA logistics chain. Losses occur at multiple points between when an order is procured and when it is delivered to beneficiaries. Losses could result from damage, spoilage, theft, and other preventable (or unpreventable) issues.

A QR Code solution could reduce some subset of the preventable losses in the future, under the assumption that improving the quality of data available to the organization would, in turn, allow BHA to address some of the newly identified "pain points" (consistent points where losses occur) in the supply chain.

The quantity of reduction in food losses would be the difference between food lost in the status quo and in the scenario with the intervention, measured in metric tons. The quantity of food lost in the current status quo can be estimated from administrative data and discussions from relevant stakeholders.

The amount of food that would be lost after the solution is implemented will be difficult to forecast accurately, in part, because the data on losses is not collected systematically (ironic, and a strong argument on the side of implementing AIDC systems). However, as an upper bound, we know the value cannot exceed the total losses in the current system. We can estimate total losses in the current system as a starting point and apply an estimated loss reduction factor that is based on observable improvements in comparable interventions. Because this parameter will be highly speculative, we will need to consider extremely conservative values (as low as 0 percent) as part of the model sensitivity analysis.

The economic value of the reduction in total food losses would be calculated using a willingness-to-pay (WTP) estimation in an ideal world where we have access to a significant amount of data or could directly study the beneficiaries of the program. However, estimating this benefit in such a fashion is currently impossible, due to data and resource constraints. Instead, a more conservative estimation strategy can be used that assumes the value of each MT of food lost is equal to the average cost of procurement and delivery for that commodity.

CALCULATION

$$B1_t = (C \times (1 + g_c)^t) \times (P \times \left(1 + g_p\right)^t) \times (L_{W/O} - L_W)$$

Where:

C is the total cost of procurement for commodities in the base year

$g_c$is the annual growth rate (%) of commodity tonnage procured

t is the time (in years) since the program began

P is the total weight (in MT) of commodity procured in the base year

g_p is the annual growth rate (%) of commodity prices

$L_{W/O}$ is the percentage of losses without the QR code solution

L_W is the percentage of losses with the QR code solution

PARAMETERS

PER MT VALUES OF FOOD (BHA RECORDS)

The model uses a value for food shipped equal to $528 dollars per ton. This is based on the 2018 USAID Packaging Data and is calculated by dividing the total spent on food into the total volume of food.

These numbers are from BHA's procurement data. [18]

[18] USUM PO Line Report 2011-2019.xlsx, Shared by BHA Staff in 2020

GROWTH RATES (2019 BHA DATA AND HISTORICAL INFLATION)

The model currently assumes that the growth rate for the volume of commodities shipped is 0 percent. This is based on recent trends in the annual average volume of in-kind title II food aid.

The growth rate for the price is 2 percent. This is based on average inflation rates over the last decade. [19]

VOLUMES SHIPPED (2018 DATA)

The model uses the 2018 numbers for BHA commodity shipping as the starting point for analysis. These numbers will change over time as a function of the growth rates.

The total weight of commodities shipped to the Prepo warehouses is 176,580 MT.

The total weight of commodities shipped to partners is 1,096,311 MT.

REDUCED LOSSES PERCENTAGE (SURVEY)

In our model, we consider the additional cost that may be incurred by adding QR codes to woven PP bags. This extra cost could be associated with changes to the design or material specification of bags or could represent additional processes, such as stitching a label onto the bag. Because the woven bags comprise most of the packaging in the supply chain, the marginal costs of changing specifications are significant and will need to be further investigated before proceeding to the full AIDC rollout.

We use the survey data to estimate an additional cost of 59 cents a bag, though there are many suppliers who responded that they don't know what the marginal cost of QR printing would be, and therefore, we consider alternate values for our scenario analysis. Based on our conversation with bag suppliers, we learned that in a worst case scenario, if printing is impossible on the woven bags, tags could be sewn on for an estimated 11.5 cents per bag. We use this value as an upper estimate in our additional scenarios.

BENEFIT 2 - REDUCED DEMURRAGE FEES

When food at a port is not promptly unloaded and moved to its next storage facility, demurrage fees may be charged to the responsible party. These charges are based on the volume of the unmoved cargo and the length of the delay.

The AIDC/QR codes could help reduce these costs by improving the quality of data available to relevant stakeholders and their ability to optimize logistical procedures at warehouses, ports, and the like. Smart systems could be designed that would make it easier to see where in the supply chain shipments are being

[19] Inflation, consumer prices for the United States, June 24th, 2020, St Louis Federal Reserve, https://fred.stlouisfed.org/series/FPCPITOTLZGUSA

held up and adding demurrage costs so that such issues can be addressed. Alerts could be sent to the responsible parties indicating when they are at risk of incurring a demurrage charge.

The reduction in demurrage charges will be estimated by multiplying the value of the demurrage charges in the current scenario, with an estimated change in demurrage charges in possible future scenarios. The initial demurrage costs come from historical BHA data, while the expected future demurrage costs would be an estimate based on stakeholder estimates regarding which portion of costs is preventable.

CALCULATION

$$B2_t = \Delta D^{\%} \times D_t \times (1 + g_c)^t$$

Where:

$\Delta D^{\%}$ is the percentage reduction in demurrage costs as a result of the new QR codes.

D_t is the average annual cost of demurrage in the base period.

g_c is the growth rate of commodities delivered annually

t is the number of years elapsed.

PARAMETERS

ANNUAL DEMURRAGE FEES (BHA RECORDS)

The annual demurrage fees are an average of the 2014-2016 numbers provided to us by BHA. [20] These numbers are based on $1.4 million in demurrage costs incurred by WFP over those years, and therefore could be a lower bound for all partners. The model, therefore, is currently using an estimate of $700,000 annually.

CHANGE IN DEMURRAGE FEES (AUTHORS ASSUMPTION)

Anything between zero (no change) and the total value (a full elimination of demurrage fees) seems reasonable. The model currently assumes 50 percent.

RESULTS

If the model's assumptions hold, this is a fairly significant benefit stream. If these demurrage fees really are an annual occurrence in a similar magnitude to the 2014-16 years, this could easily justify a large investment if they can be reduced through enhanced tracking and data visibility. Demurrage fees are an example of a cost that an actor with good planning and full data visibility should not have to pay very often,

[20] The Future of the Food for Peace Supply Chain: Automatic Identification and Data Capture (AIDC), November 17, 2017, Prepared by BHA's Operations Team

and therefore it does not seem unreasonable to assume that at least half of this cost could be eliminated with the AIDC system.

BENEFIT 3 - REDUCED TRACING COSTS

If commodities have information-rich QR codes printed of them, it should be easier to manage recalls, since the relevant data points (such as batch number, packaging date, and the like) will be accessible to any warehouse worker who scans a package with their phone.

The recall process will be even easier if a fully integrated AIDC system is implemented. If commodity locations are recorded into a central database, the recall process could be as easy as simply updating the status of a subset of commodities to "Recalled," and the system could send updates to the party in possession of the relevant commodity.

The value of this benefit will depend on both the expected cost of recalling food in the absence of the solution over the time-frame analyzed and the impact of QR codes or AIDC systems on these costs.

CALCULATION

In our model, we estimate the cost of reduced recalls via tracking and tracing as:

$$B3_t = (R_p \times R_q) \times 0.14 \times TR \times (1 + g_p)^t$$

Where:

R_p is the price (in USD per MT) of recalled food.

R_q is the average quantity (in MT/year) of recalled food.

TR is the percentage reduction in recall costs associated with improved traceability.

g_p is the annual growth rate (%) of commodity prices

t is the number of years that have elapsed

We use a methodology similar to that is found in a 2010 paper of traceability benefits in the beef industry, which found that the cost of recalls was equal to the total value of the commodity recalled, plus approximately 10 percent for logistical management and 4 percent for communications. [21] Because the logistical costs and communication costs are the components that would reasonably be affected by the solution, we assume that 14 percent of the underlying commodity value can be addressed by improved traceability. Fourteen percent is the absolute upper bound for our benefit in the mode, and we then apply a reduction factor that corresponds to the overall effectiveness of the new system.

[21] "Economics of traceability for mitigation of food recall costs", Resende-Filho, Moises and Buhr, Brian, 27 December 2010

PARAMETERS

RECALL QUANTITY (BHA DOCUMENTATION)

The team was able to access the recall scheduled for 2019, in which a total of approximately 8,000 MT of food was recalled for reasons such as pests, water damage, fires, and the like.

VALUE OF FOOD (2018 DATA)

This estimate is the same as that used in the food loss section.

REDUCTION FACTOR (AUTHORS ASSUMPTION)

The model assumes a reduction in recall logistics costs of 25 percent, though higher or lower values are conceivable. The true value will depend on the efficiency with which data is used.

COST 1 - FIXED UPFRONT INVESTMENTS COSTS

The immediate costs of the proposed solution that must be paid before any benefits can be actualized include designing the upgrading equipment to ensure QR labels can be output, adding scanning capacities to warehouses or ports, installing secure servers to host the relevant platforms, etc.

CALCULATION

$$C1_t = \sum_{i=1} \frac{CAPEX_i}{T_i} \times (1 + g_p)^t$$

Where:

$CAPEX_i$ is the fixed investment cost (in USD) of investment item i

T_i is the length (in years) of the investment period for investment item i

g_p is the annual growth rate (%) of commodity tonnage procured

t is the time (in years) since the program began

COST 2 - ANNUALIZED COSTS

New costs may be incurred for labor as part of the new solution. The introduction of QR codes to packaging may require additional steps to be taken during printing and additional quality control. For those involved with shipping and handling, the new solution may add to their workload, especially if the new solution requires significant scanning to occur.

Calculation

$$C2_t = \sum_{i=1} \quad O\&M_{i,t}$$

Where:

$O\&M_{i,t}$ is the annual operational cost of type i in period t

COST 3 – INCREMENTAL PRINTING COSTS

The model calculates additional costs that may be required to add QR codes to the woven PP bags. This solution might be a change to the current bag design to facilitate scannable printing, such as an additional laminated face or an addition like weaving a tag on that is easily printed on.

Calculation

$$C3_t = \left(P \times \left(1 + g_p\right)^t\right) \times 20 \times PPB_{\%} \times C_{PPB}$$

Where:

t is the time (in years) since the program began

P is the total weight (in MT) of commodity procured in the base year

g_p is the annual growth rate (%) of commodity prices

$PPB_{\%}$ is the percentage of all commodities (by weight) shipped in polypropylene woven bags

C_{PPB} is the average per bag cost of printing QR codes

ANNEX VI. PREPO PILOT COST ESTIMATES

At the request of BHA staff, the team has budgeted the potential cost of piloting QR codes for a single PREPO warehouse (Houston or Djibouti for example). The primary costs will be the underlying application and IT infrastructure, with some additional resources budgeted for printers, scanners, and excess packaging costs. These costs are illustrative estimates only and will need to be reviewed during procurement and implementations.

Cost Item	Value	Value	Unit
Common QR Code Repository Application Design[22]	$150,000	51%	USD
QR Code Operational Cost - Web Server	$12,000	4%	USD
QR Code Setup & Integration into HIMS	$10,000	3%	USD
QR PREPO Printers & Possible Additional Pilot Costs	$75,000	25%	USD
Procurement costs for adding QR Codes	$48,312	16%	USD
Total	**$295,312**	**100%**	**USD**

[22] This is a one time fixed cost that can be carried into any expansion in the future.