From reactive to proactive: A novel approach for decision support in the context of a humanitarian supply chain

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Dissertação de Mestrado

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Mestrado Integrado em Engenharia Industrial e Gestão

2018-01-22

To family, friends and girlfriend

Resumo

A presente dissertação foi realizada no contexto de uma organização Humanitária.

Esta reflete uma solução informática inovadora encontrada para resolver um conjunto de problemas com os quais uma cadeia de abastecimento humanitária se depara, problemas estes definidos através de métodos de "Business Research".

Fazendo uso dessa mesma solução informática pretende-se chamar os atores desta mesma cadeia de abastecimento para a possibilidade de ocurrências que possam ser putativamente disruptivas para a mesma, com consequências para os indivíduos aos quais se destina.

A implementação desta solução traz ao mesmo tempo mais visibilidade para a toda a cadeia e uma visão mais integradora dos processos envolvidos.

Abstract

The present dissertation was carried inside a humanitarian organization.

It reflects an innovative informatic solution found to solve a set of problems with which the humanitarian supply chain is faced daily.

The problems targeted were in turn defined through a Business Research approach.

Making use of the same informatic solution it is intended to raise awareness in the actors involved with the supply chain for the possibility of events that may be disruptive for it, with possible consequences to the individuals by the supply chain targeted.

The implementation of this solution brings at the same time more visibility for the entire supply chain as well as a holistic view of the processes involved.

Acknowledgements

I would like to start out by thanking to the team of the planning service.

Nina, Wouter and Khalid for making data ,crucial for the elaboration of the project, available.

To David and Sumit for their support, motivation and advises.

To Tim,Sangeeta, Beverley,Koen, Rui and Luis for welcoming and making me feel part of the team.

To the Palantir team for providing me access to an innovative and beautifully designed software.

To Prof.Pedro Amorim my orientor.

Special thanks to Mr.Sérgio, my orientor in WFP, for giving me the opportunity to make my thesis in such an interesting and challenging environment.

Non of this would also be possible without the support of my family and my father's advises as well as the constant support of my girlfriend to whom i would also like to dediate this thesis.

Content:

Acronyms:

AED - Assistant Executive Director

AF - Advance financing

AP - Assignment plan

CFO - Chief Financial Officer

CO - Country Office

COBS - Chief of Organizational Budgeting Services

CTR - Consolidated Transport Report

DRO - Donors' relationship officer

FCR - Full Cost Recovery

FP - Funding proposal

GCMF - Global Commodity Management Facility

HQ - Head quarters

INT - International Procurement

IPL - Internal Project Lending

IRA - Immediate Response Account

LOC - Local procurement

LESS - Logistics Execution Support System

MT - Metric tons

OCSC - Food Procurement & Shipping Service

OS - Operations Service Department

OSC - Supply Chain Department

OSCP - Planning Service

PGG - Government Partnerships Division

PO - Purchase Order

PR - Purchase Request

RB - Regional Bureau

REG - Regional Procurement

RM - Resource management department

RMB - Budget and Programming Division

RMBP - Project Budget and Programming Service

SRAC - Strategic Resource Allocation Committee

WINGS - WFP Information Network and Global Systems

Figures:

Tables:

1 Introduction

The number of disasters has been growing steadily in the passing years (Gyöngyi & Karen, 2009). Furthermore, as it is noticed in Tomasini & Van Wassenhove (2009) coupled with the rise of more complex and frequent disasters donor support is becoming increasingly unpredictable appearing often with restrictions to its use. This increased pressure and entropy over humanitarian supply chains demands for the optimization of existing resources and new and bold approached to tackle the stress that an increase in disasters and lack of resources puts over already fragile systems.

Further impelling this pressure are humanitarian supply chains own characteristics. These often appear unpredictable in nature and characterized by suddenness occurrence of large scale demand with short lead times and lack of financial, material, people and technology resources.

Given the present scenario above described, good management and timely decision regarding the scarce resources available in such environment reveals itself fundamental.

To achieve that in an everchanging system with constantly evolving parameters, visibility regarding material, information and financial flows acquires an increasing prominent role.

Current literature suggests that the two major concepts around which Supply Chain visibility oscillates are the exchange of information for the purpose of decision making (allowing companies to act on timely accurate information) and technologies that enable that same visibility to be created (Stanchik 2016).

The present dissertation concerns a technological solution for decision support in a humanitarian supply chain. Driven by available organizational data and at the same time availing itself of a new bigdata software (currently under implementation in the organization) the present work aims at promoting promptly action and visibility throughout the hole supply chain.

The results will be presented in an information system’s platform elaborated in Palantir’s software, Foundry, using PostgreSQL in the elaboration of the visual platform and Spark SQL for data transformations.

1.1 Organization

The dissertation was developed inside World Food Programme (WFP) one of many UN specialized agencies and the biggest humanitarian food aid organization whose main purpose is to eradicate hunger worldwide.

From distribution of food in areas where it is scarce or cash-based transfers to support local economies. Using ground-breaking technology to help forecast emergencies and respond quickly to them. Doing country capacity strengthening, offering countries technical assistance services to facilitate the design, and delivery of sustainable national solutions to combat hunger and malnutrition. WFP acts on many fronts, by ocean by land or air. From Honduras to Djibouti it goes everywhere where it is needed. For that it establishes itself as a decentralized organization being present in over 80 countries (see figure 1) which further accentuates its diversity and complexity.

Figure 1: Countries where WFP is present

WFP must report to the Economic and Social Council, one of the 5 UN organs, in accordance with article 63, chapter X of the UN Charter[1].

As an UN intergovernmental organization, it is autonomous having its own procedures and independent governance, with an executive board in part elected by the UN General Assembly.

Being part of the UN, it is ruled by a strict code of ethics deeply entrenched in WFP's culture which spans across all parts of the United Nations universe.

Furthermore, it is in sync with the SDGs (Sustainable development goals) of the 2030 Agenda for sustainable development.

WFP encompasses 2 of 17 SGSs in its corporate strategy namely:

Goal 2 "Zero Hunger" (End hunger by protecting access to food and improving nutrition)

Goal 17 "Partnerships for the Goals" (Support SDGs implementation and partner for SDGs results)

That becomes clear when one looks at WFP's work in the field, by giving access to food to everyone, strengthening smallholder's productivity and incomes through the share of knowledge and expertise and by strengthening global partnerships support to country efforts in achieving the SDGs

[1]http://www.un.org/en/charter-united-nations/index.html

WFP is also one of the 3 Rome based UN agencies with FAO (Food and Agriculture Organization) and IFAD (International Fund for Agricultural Development) that together constitute the International Alliance Against Hunger (IAAH).

Structurally WFP has 3 types of basic organic structures.

Every country where WFP operates has a Country Office with its own organizational structure touching all the key activities from funding to downstream logistics management and beneficiaries targeting.

These Country Offices are in turn organized in administrative areas, Regional Bureaus (RB) (see annex A), which help coordinate and support COs' activities.

There are 6 RBs concentrated in South America, Africa, Middle East and Asia.

To consolidate the organizational activities there is the Head Quarters in Rome.

It gives support to all WFP's COs, establishes guidelines and policies and helps consolidating the operations at a global level.

It is specially focused on the management of global operations at an upstream level, dealing with planning, funding, procurement and shipping.

At a downstream level functions are predominantly decentralized, dealt by the COs, with first line support and oversight provided by Regional Bureaus.

Exceptions to this occur when the situation on the country reaches a certain critical level, being the downstream supply chain also managed by the HQ. Such can be easily elucidated through the humanitarian emergency levels:

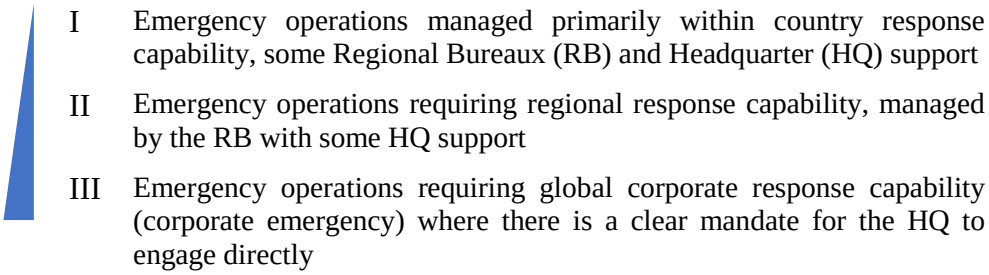


Figure 2: Humanitarian emergency levels

WFP can be seen as having a mixed organizational structure. As a whole (HQ, RBs and COs) it displays a clearly organic structure, being the most notable characteristic its decentralized authority. On the other hand, each organic structure has a clear mechanistic approach. This becomes evident in the HQ with rigid hierarchical relationships, formalized communication channels and tall functional structures with a relatively high span of control.

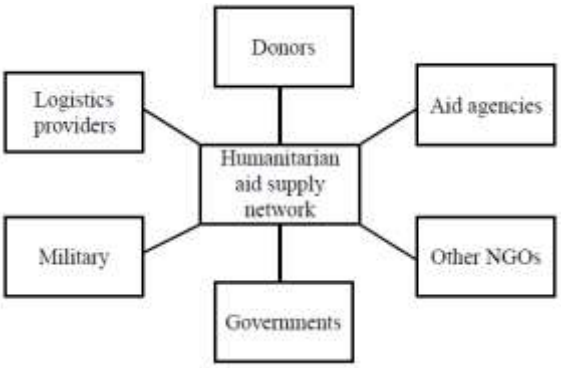


Figure 3: WFP's stakeholders taken from *Gyöngyi & M. (2007)*

Its universe goes well beyond the organization itself. There is a myriad of stakeholders ranging from governments, NGOs, suppliers to local communities, the private sector and smallholder farmers as suggested by figure 3, which reflects the organization's need to cooperate in order to be successful.

That complexity is also perpetuated by the range of services provided:

- Procurement of food, relief items, and operational equipment
- Emergency stockpiling and pre-positioning
- Cargo transportation
- Telecommunications and IT services
- Air passenger transport
- Warehousing and handling
- Engineering support
- Medical wellness and accommodation services

Despite the vast range of services offered varying broadly, both physically and procedurally, the main focus concerns food and cash transfers to beneficiaries (receptors of WFP assistance, usually food insecure and vulnerable people).

Such transfers are only possible thanks to the donor's generosity, which can range from governments to private donors and can be comprised in two main types:

- Cash, which will then be used in all operational expenses both direct (to purchase food and the fleet to transport it) and indirect (all the committed staff that works indirectly to the operation as well as all the administrative costs implied)
- Food in-kind, which translates in food given by the donors to feed the beneficiaries

1.2 Operations

Programme or project is a broad term in WFP which stands for a group of processes, tools and activities with which WFP is able to assess a situation as well as target and assist populations in need.

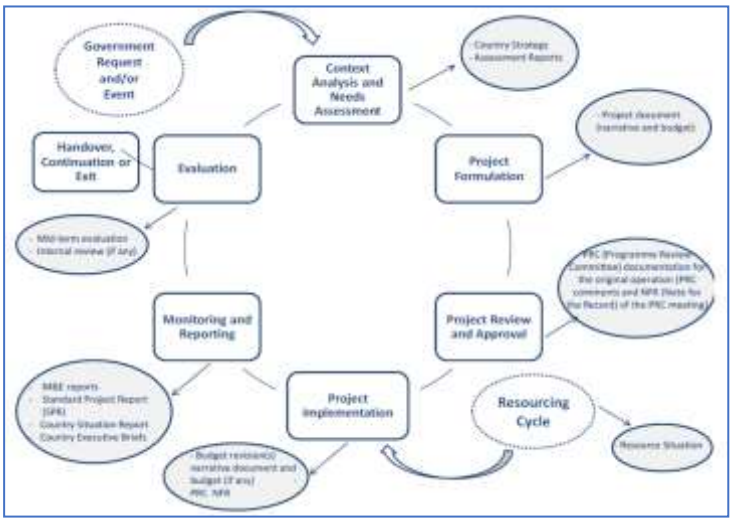


Figure 4: Programme cycle

The programme cycle is comprised in many steps, which in generic terms is summarized in figure 4. It ranges from the analysis of the local context and assessment of the needs, with focus on food and nutrition, to implementation, review and evaluation of the programme followed by the redesign of the operation.

Assessment is the First critical element of a programme's information which gives basic information concerning the beneficiaries, their characteristics, their number and their livelihoods.

Such assessments can be pre-crisis, to have a country's food insecurity situation picture, like the Comprehensive Food Security and Vulnerability Analysis (CFSVA), or they can be undertaken following a disaster to determine the impact on households and livelihoods like the Emergency Food Security Assessment (EFSA). This last one is usually used as the basis for design of emergency operations (such as EMOPs and PRROs further down explained), providing recommendations on food and non-food assistance.

After the assessment, a programme when implemented can have many activities as well as transfer modalities associated with it.

Activities can be categorized in two broad groups:

i. transfer-based activities that consist in providing food, including specialized nutritious foods, and cash/voucher assistance to beneficiaries.
ii. capacity development and augmentation activities (CD&A) that do not entail the provision of food assistance.

Such activities can be found subdivided in categories like general food distribution, school feeding, nutrition programmes and HIV and tuberculosis programmes.

Activities can be further striped down to better adjust to the targeted beneficiaries needs. (e.g. a nutrition program can be subdivided in treatment of moderate acute malnutrition and prevention of acute malnutrition programmes)

To deliver assistance to beneficiaries a CO must have an approved operation in place which can be categorized in 4 types as depicted in table 1:

Table 1: Types of operations

Operation type	Description	Duration
Emergency operations (EMOP)	Food assistance to meet emergencies such as: Sudden disasters/calamities (e.g. earthquakes, floods...) Refugees influxes, displacement of populations	Between 3 and 12 months
Protracted relief and recovery operations (PRRO)	When an EMOP is not enough to stabilize the area and continuous assistance is further needed	Between 2 to 3 years
Country programmes/ development projects (CP)	Rehabilitation and disaster preparedness projects Technical assistance to help developing countries establish/improve food programs.	5 years
Special operations (SO)	Short-term operations. Usually complement EMOPs and PRROs. Encompass repairing and construction of infrastructures and equipment	Variable

These operations appear in different points in time, according to the situation a country finds itself, and concern different objectives as depicted in figure 5.

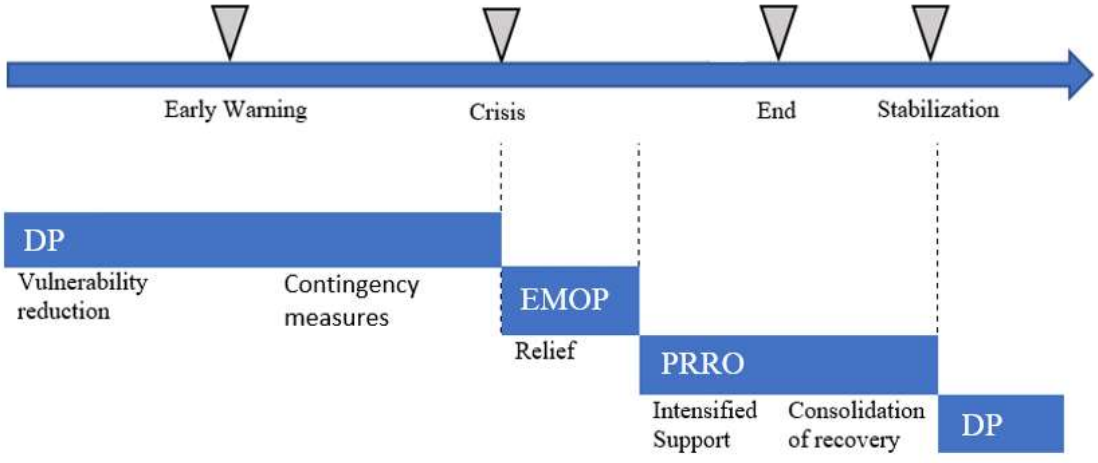


Figure 5: Operation's type as per the disaster timeline

Appearing in different moments in time, they will also have different operational characteristics, already mentioned in table 1, and different levels of engagement from WFP.

Having framed the organization globally a more detailed description with the framework of the project and where it is inserted follows.

1.3 Supply Chain department

To manage such complexity the organization disposes of different managerial departments which entail different purposes.

In its structure, at the top of the pyramid, the Executive Director is supported by 5 arms being one of them the Operations Service Department (OS)[2].

Under the umbrella of the OS one can find the Supply Chain department (OSC).

This department is responsible to manage the entire process end-to-end, from funding to the beneficiaries, covering all functions and sub-processes, implementation of programs, monitoring, and evaluation downstream.

WFP's core supply chain functions include:

- Planning (demand and funds forecasting, sourcing and delivery planning)
- Sourcing (procurement of commodities and supply chain services)
- Delivering (transportation, storage and distribution of food assistance

The 5 major components dealt by this department are[3]:

- In-Kind Food Assistance
- Food Procurement
- Logistics
- Cash-Based Transfers
- Goods and Services Procurement (non-food items necessary to ensure the unroll of the operations)

Being the keystone of WFP and the link between the organization and the beneficiaries it usually deals with a budget in the order of billions of dollars per year:

"shared supply chain services and safe and quality food, goods and transport worth and average of USD 3 billion per year".[4]

For what any initiative pertaining to its optimization, if successful, could generate considerable savings.

[2] For a clearer picture of the organization please see Attachment B

[3] According to the WFP Supply Chain Annual Report 2015

[4] Quoted from WFP Supply Chain Annual Report 2015

1.4 Planning service within the Supply Chain department

The planning service (OSCP) is part of WFP's integrated supply chain management approach to end-to-end planning.

By end-to-end planning it is understood the capacity to design, organize and plan the operations strategically which yields thereupon the capacity to generate reliable demand forecasts, design of optimal operations and an enhanced ability to identify challenges and opportunities in sourcing and delivery operations through the analysis of sourcing options, transport corridors and transfer modalities.

This service can be briefly summarized through the following statement**:** "The Planning Unit works with RBs and COs to bring together operational units and expertise, not only within OSC but also from other Divisions, such as Programme and Donor Relations. Our end goal is to provide COs with the best solutions, by using every available innovation and expertise in our toolbox" [5]

This Supply chain branch structure can be understood through figure 6.

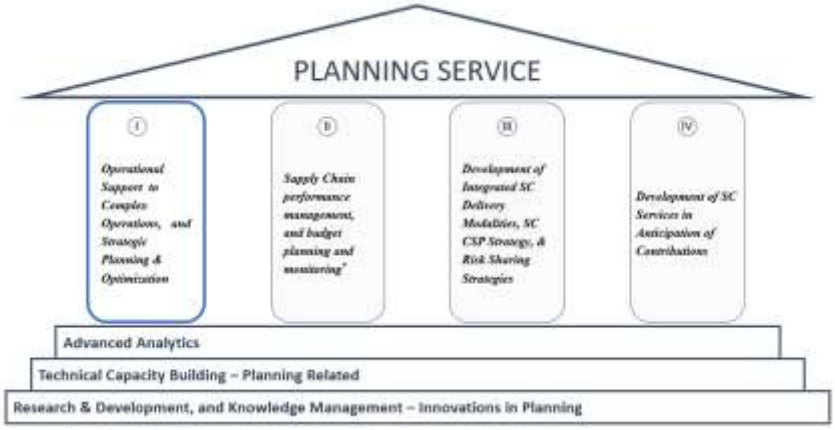


Figure 6: Planning service's constituent teams

The Planning service is supported by 4 independent pillars within which one finds teams with different work streams that albeit independent are imbedded in each other
It should be noted that WFP Supply Chain planning and optimization is a relatively new department within WFP SC workstream that shoulders with all the other departments of the organization.

Very dynamic and innovative in its approach, it still has to overcome political barriers and resistance to the change it tries to implement.

It was inside pillar I, whose mainly purpose is to give support to complex operations (L3 operations), that the project was developed.

[5] http://newgo.wfp.org/about/sc-planning

By support to complex operations it is understood support at a strategic and operational level, both concerning optimization of resource allocation and reduction of lead times, through the integration of the programming, procurement, shipping and transport processes.

To do so the branch of the planning service defined in pillar I finds itself divided in 4 different workstreams as follows:

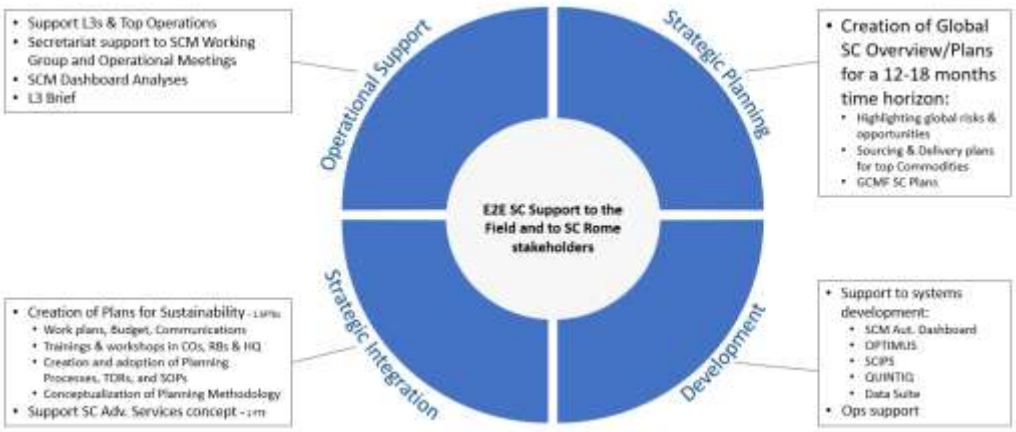


Figure 7: Workstreams of Planning service's team (kindly ceded by the team)

Which should be carefully considered during the project's development for the exploration of possible synergies. Figure 7 lists what functions fall under each stream.

1.5 Data systems

The 2 major systems in place are WINGS and LESS.

WINGS (WFP Information Network and Global Systems) represent a number of systems integrated with WFP's Enterprise Resource Planning (ERP) system SAP.

SAP is the core system in WINGS which is used to manage the many facets of WFP's business, including programme/project planning and implementation, procurement, supply chain, finance, travel and human resources.

It is from wings that all the information pertaining to the resources availability (e.g. resources available to purchase food) is going to be extracted.

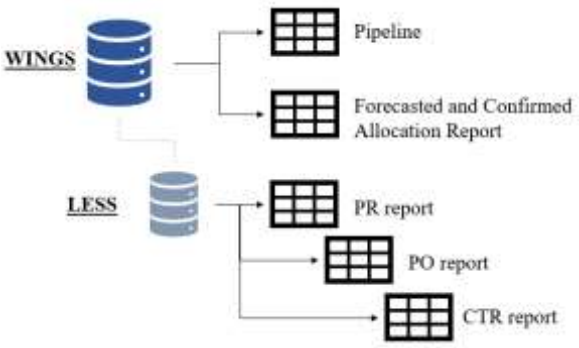


Figure 8: Data systems used along with main reports in them available

Integrated with WINGS we find LESS, WFP's global supply chain and commodity tracking system, which is used to monitor the movement of commodities from the time they are first requested by field officers in the CO to their handover to country partners, warehouses or other final delivery points.

These 2 systems will be critical for the project since it is from them that most information is going to be extracted (see figure 8 for a clearer picture).

Other important systems for the SC department are, at a strategic level, OPTIMUS (for the operations design). A software tool that helps country offices identify the most effective and efficient supply chain within parameters of funding and operational constraints while also maximizing nutrition outcomes and value for money. And at an operational level and currently under development, Quinteq, that uses scenario-planning technology to assess the cost and impact of different approaches in the operation's theatre, giving both the procurement department and planners insight into possible options that can enable them to make more cost-efficient purchases.

Other data initiatives like INFOHUB, which is a web based reporting platform, are also being developed. INFOHUB displays some statistics related with the supply chain e.g. how many metric tons are in high see, how many are in stock in each CO, how much stock almost reaching BBD (best before date) does a CO holds.

1.6 Dissertation structure

The project consists in a warning system tailored to the problems of a Humanitarian Supply Chain.

A warning system as defined by this project consists on a platform that draws data from the existing data management systems, transforms and makes estimations over it based on pre-defined assumptions and warns a user (alarm) about those same estimations.

It has the objective of helping WFP's staff to make timely decisions in various activities that the provision of food to beneficiaries entails, bringing at the same time more visibility over the entire supply chain. The staff concerned in the warning is the one working specially at a CO level.

To achieve that the project was broken down in 3 main categories:

- Business research
- Process Mapping & Systems mapping
- Data system development

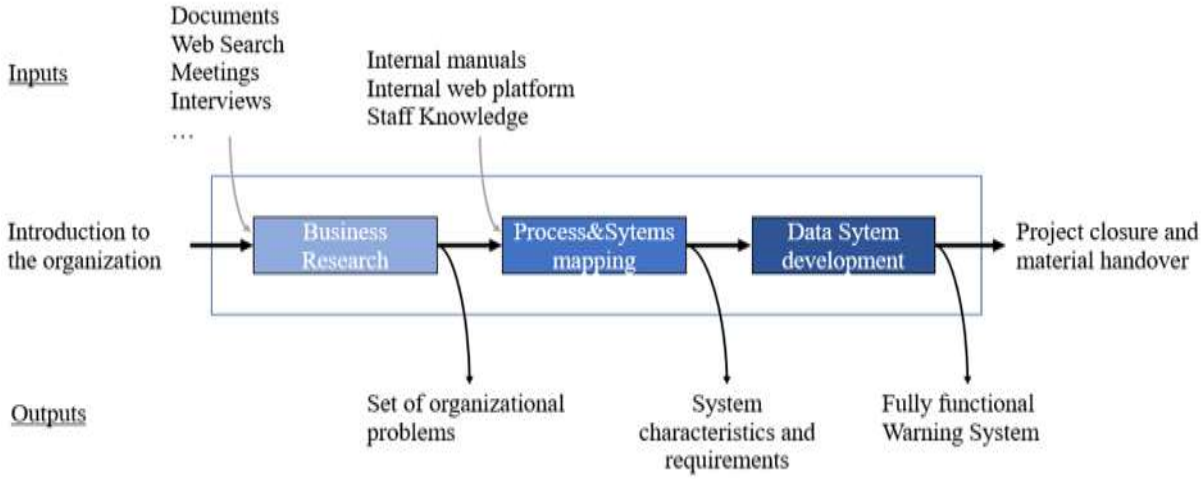


Figure 9: Project's workflow

In chapter 1 the project is framed in the organization. Here we can see how does the organization work and where will the project be inserted.

In chapter 2 through a business research approach we arrive to a set of defined problems to be depicted in the warning system.

Having the set defined, chapter 3 follows with the designing of the process flows where these same problems occur as well as the description of LESS operations, given its preponderance for the work being developed. These chapter will be later on used for the design of the warning system.

Chapter 4 then describes the concept of a warning system and its requirements as well as the software where the solution is going to be built.

In Chapter 5 on tries to describe in the most concise manner the steps taken in the conceptualization and programming of the warning system used for decision support. At the end of this chapter the limitations of the work developed are also presented.

The present dissertation will then be concluded in chapter 6, where an evaluation of the work developed is made, as well as some remarks regarding the future of the project.

2 Problem development

The scope of the project was drawn from the statement presented below:

"WFP is moving a significant amount of cargo every year and a lot of transactional data is being captured along the way. However, as of yet WFP is not fully leveraging the available information to proactively flag issues in its supply chain."

The objective is to develop a tool to enhance end-to-end visibility, support operational effectiveness and better decision making by the anticipation of operational issues.

"Supply Chain Visibility is all about how organizations capture and interconnect data to extract critical supply chain execution information. It provides a single view for tracking information, material and/or cost by monitoring key dimensions" Bhosle et al. (2011).

End-to-end visibility in the supply chain can be seen as a key element in the strategy to mitigate supply chain risk (Martin & Hau 2004) since having the knowledge of the processes taking place at each stage of the Supply Chain allows for WFP to determine potential threats as well as to identify opportunities to optimize time, cost and service quality (Sithole et al 2016).

This tool should be rooted in corporate data, and cover WFP operations end-to-end by connecting data and stakeholders from funding to supply chain operations. During the development it must be ensured that the tool is designed in such a way that they are relevant and easily implementable by any Country Office following the principles of end-to-end supply chain planning:

Cross-functional collaboration: across all of WFP, and across all level

Alignment: must be strategically aligned with WFP's SC strategy

Getting the full picture: connecting the dots, and being holistic and informative

Anticipation: anticipate demand, leveraging opportunities, and mitigating risks

Optimization: ensuring that our SC is reliable, agile and cost-efficient

Innovation: promoting integrated delivery modalities and other novel approaches

To get optimal results the project ought to contact and collaborate with the different streams (figure 7) leveraging on inside knowledge and projects under development. Furthermore, not being developed under a specific stream of work it should be conceptualized in a way that it can be deployed in current business processes without much effort i.e. the output of the project ought to be a turnkey solution[6].

It was reported in the beginning of the project that WFP's supply chain had problems and inefficiencies that could be possibly tackled by existing information.

Given that, the first part of the project starts by identifying clear problems and data sources from where information could be extracted to possibly bring visibility over the same.

[6] https://www.investopedia.com/terms/t/turnkey_solution.asp

2.1 Analysis of Supply Chain issues

In the first part of the project it is intended to answer the following research questions "What problems should be considered in the project?"

To do that one can resort to Business Research. A systematic process of inquiry employed in the search of the truth about business phenomena. It is a method that deals with the definition of business opportunities and problems, ideas generation and evaluation, as well as the understanding of business processes.

This following chapter concerns the definition of a set of problems present in the supply chain that answer the research question above, being subdivided in two parts:

1. Qualitative research to collect problems and arrive to a final set to work on
2. Quantitative research to validate the problems

Qualitative research design was employed as a first approach to answer the research question. This approach comprehends the selection of the empirical material (situations, cases…) that are going to be used to reach a final set of well-defined problems.

In the end of this process the set of problems should be agreed upon by staff of the department.

Although a qualitative research may lack in objectivity, when compared with a quantitative one, they provide rich and deep insights into the phenomenon under study and a good initial approach to broad and not well delimited problems.

The second part, after the compilation of problems, consists on its validation through data analysis.

2.1.1 Qualitative Research

Two of the main forms of data collection is by asking people (through surveys and interviews) or studying documents (Flick 2015). In the present case data was gathered from:

- Existing documentation in the organization (Budget and programming manual, dashboard, Global SC planning monthly meeting documents, KPIs, internal documentation present in the WFP web's repository[7])
- Problems found during the acquaintance with the SC reports (purchase order's report and purchase request's report) used to track commodities
- Interviews and meetings with WFP staff members.

The qualitative research approach, making use of the data sources above mentioned, will be comprised in 4 steps:

1. **Step 1**
   Organizing the data in the form of problems to be later on explored
2. **Step 2**
   Framing the problems in the context of the supply chain
3. **Step 3**
   Filtering the problems
4. **Step 4**
   Defining the problems in the context of an alert

[7] http://newgo.wfp.org/

Step 1

The data gathered[8] was prepared so it could be properly analysed. By preparing it is understood sorting and summarizing the data for it to reflect only the Supply Chain problems. For that purpose one can resort to coding, a method vastly employed in qualitative research to label summarize and synthetize qualitative data in a structured way.

e.g.:
"…it is hard to make an analysis about lead time because a lot of the times the RTA, ATA, GR doc date is wrong because someone didn't write it correctly, so the RTA must be estimated when making an analysis of the PR/PO file." (text extracted from a meeting's notes)

Possible problem:

System is too much reliable on staff being prone to data being incorrectly inserted

Step 2

After collecting the problems, they were organized according to their stand in the supply chain process to have an integrated view over the points from where these radiate and better communicate them to the staff.

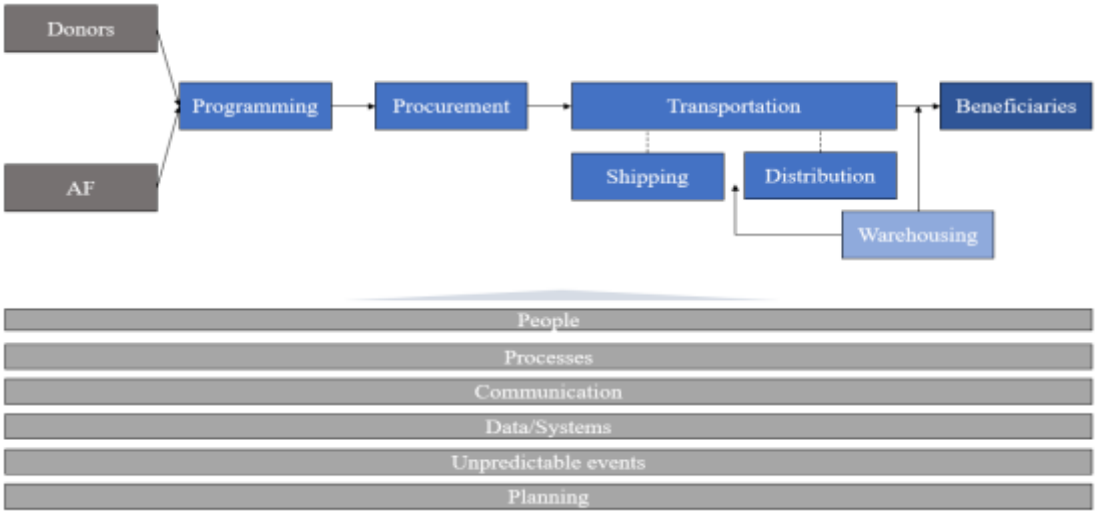


Figure 10: Supply chain activities and elements involved

The problems were subdivided in two types of categories. One (upper part of figure 10) concerns tangible problems directly involved in the supply chain process. The second part concerns problems that are not tangible, such as unpredictive events, communication problems, processes, planning problems (e.g. war erupts in a certain area and WH becomes unavailable), or problems that are related to support to the operations such as people and data systems.

[8] The data collected can be seen in attachment C.

Step3

The final list was brought up to some elements of the planning service team for further discussion. With that it was intended, by using the team's inside knowledge, to reach a final list of problems that actually reflected relevant problems faced by the SC department with enough reliable data to explore them.

To do that 3 metrics were employed as portrayed in figure 11:

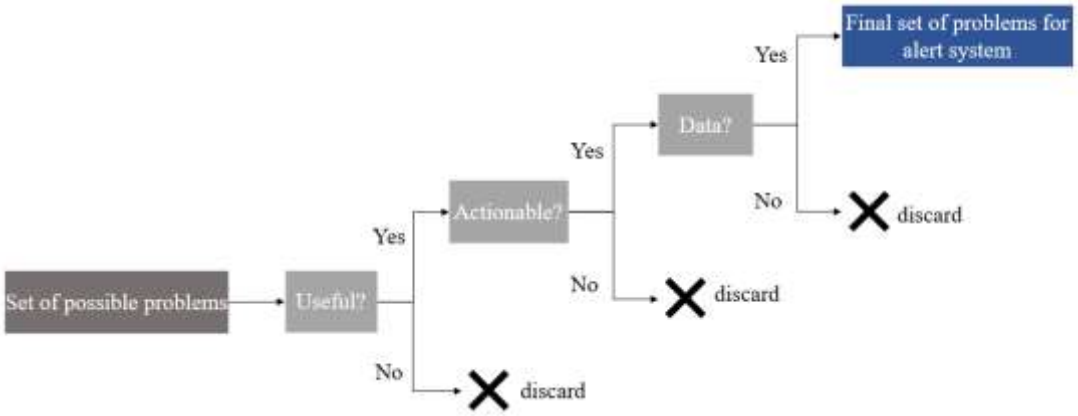


Figure 11: Metrics employed to reach final set of problems

After having the collection of problems organized by the areas in which they appear and given the fact that they span from many different data sources with different degrees of reliability, the first thing to do is to define which ones might be useful to see portrayed in the warning system. For that one has to determine if they reflect real constrains that fall under the planning's service scope of action. (e.g. problems related with donors will fall under the scope of PGG rather than the planning department). After that one has to wonder if, for the problems selected, there is the possibility to act on them when warned. Finally, one as to ask itself about the feasibility to develop a warning over these same problems i.e. if there is enough available data and easily accessible concerning these same problems.

Step 4

Having fulfilled the 3 conditions depicted in figure 11 a list of problems was compiled in table 2, reflecting the category of alert where they could be portraited i.e. the areas of the SC which the warning system targets.

Table 2: SC's problems collection as per the alert where they could be portrayed

Funding alert	Reporting to donors for fundraising underestimate the future funding requirements **(#1)** **Funding needs not dully communicated on-time (#2)** Low funding forecast at the moment doesn't allow the activation of AF mechanisms for upcoming months shortfalls **(#3)** AF not repaid **(#4)** **Grant not programmed immediately, or TOD almost reached (#5)** Changes on the demand not dully communicated (#6)
Lead Time alert	**Orders received with infeasible delivery lead times** (There is no mechanism in place to tell whether or not a certain request is feasible in terms of lead-time) **(#7)** Number of Days between STO planned dispatch date and actual uplift date surpass a certain limit **(#8)**
Pipeline Correctness/ Feasibility alert	When calculating Net Funding Requirements (pipeline shortfalls - unprogrammed funds + outstanding advances), available resources will be overstated **(#9)** CO submits a certain pipeline with a demand for the next months higher x% than the previous months **(#10)** Requirements/shortfalls have significantly changed from precious months (Are they explained and supported by the budget?) **(#11)** CO overstates operational requirements **(#12)**
Programming/ Procurement alert	GCMF may purchase too much or too little, or not the correct commodity and the working capital will be locked in stock that cannot be consumed **(#13)** Replenishment of GCMF stocks lower than the actual future demand **(#13)** **Source congestion (#14)** **Limited production capacity for certain commodities** (source availability for certain commodities) **(#15)** There is no communication on time with the suppliers to know whether or not they comply with what was on the contract **(#16)** Tender takes more time than what was expected **(#17)** **Procurement doesn't use a standard procedure to infer when to start with the commodities programming (#18)** Not contemplating PRs for a certain supplier when programming the commodities **(#19)**
Shipping alert	Load on corridors **(#20)** **Potential congestion in the ports used by a certain CO (#21)** Vessels don't dispatch on time **(#22)** Commodities don't arrive on time at the port of discharge **(#23)** Commodities don't arrive on time at the port of dispatch **(#24)** Assistance ordered delivered in the recipient CO on time (RTA) **(#25)** Big gap between ETS and ATS **(#26)**
Warehouse Load alert	Load on warehouse **(#27)** Potential not enough space on the Warehouse **(#28)**
Best use of BBD[9] alert	**$ and MT change in food losses due to expired best before date (#29)** Commodities almost expiring (#30)
Stock Composition alert	Stocks not correct (too much of one commodity too few of another) **(#31)** Too much inventory **(#32)**

[9] Commodities best before date

Finally, after some in-depth quantitative research (presented in the subsequent chapter) and in further discussions with some staff members the most pressing issues faced by the planning service to be portrayed in the alerts were targeted. From this exercise 4 alerts, slightly reformulated from table 2, emerged (table 3).

Table 3: Final list of problems by alert category

Programming	**Funding needs not dully communicated on-time (#2)** **Orders received with infeasible delivery lead times (#7)** **Procurement doesn't use a standard procedure to infer when to start with the commodities programming (#18)** **$ and MT change in food losses due to expired best before date (#29)**
Funding	**Grant not programmed immediately or date for its use almost reached (#5)**
Supplier congestion	**Potential congestion in the ports used by a certain CO (#21)**
Port Congestion	**Source congestion (#14)** **Limited production capacity for certain commodities (#15)**

The system will hence target problems concerning programming of commodities, aspects on funding to purchase these same commodities, congestion at a supplier level and problems on the corridors through which they pass.

Though the problems depicted in table 3 (right column) are self-explanatory a special remark should be made regarding problem #29.

Food losses in the supply chain can happen at 3 levels:

- Pre-delivery losses (incurred before the delivery point, which depending on the incoterm used may be ensured against all risks)
- Losses at the delivery point
- Post-delivery losses (losses incurred from the delivery point onwards, these include Warehouse's losses)

It is from the latter that problem #29 emerges i.e. losses that occur in the places were food is stored due to their best before day date to be reached. Simply warning about the problem (warning about when food is almost expiring) won't necessarily trigger a response, since its use may not be immediately on sight. For that reason they were incorporated in the programming warning.

When a certain CO has the urgent need for a certain commodity. Being the commodity available in a neighbour country 3 or less months away from expiring and given that there is the possibility of borrowing commodities from other countries (see chapter 3), the CO in question will have that information available in the warning system. That way, if the right conditions are gathered (i.e. the borrowing country doesn't have on sight the distribution of these same commodities and they represent a viable financial option in terms of logistics' costs involved), the CO might proceed with a borrowing process with the respective country. This will enable the possibility of tackling the BBD problem for the borrowing and the shortfall for the borrower country.

2.1.2 Problem validation

The following chapter concerns the in-depth quantitative research mentioned in the previous chapter. From the final set of problems collected through qualitative research this next chapter will proceed with their validation. The validation comprehends looking into existing historical data that might reveal their occurrence in the past. The necessity of this approach arises given the fact that there was only documentation on the port and supplier congestion (See attachment D)

Programming problem validation with Democratic Republic of Congo

With this investigation one pretends to detect past situations that might reflect a scenario where a CO had resources but because it didn't used them on time it ended up having a pipeline break, which corresponds to a situation where the shortfall in a certain month was not suppressed. The research started with a conjecture about pipeline breaks, that occurred in Democratic Republic of Congo (DRC), despite the country having resources reported by staff.

The investigation was conducted in 2 steps:

1. Check the Pipeline report for past shortfalls in the implementation plan for what was resourced
2. With the shortfalls identified, match the project number in which they occur with the project number in the unprogrammed resources report[10].

If there is unprogrammed resources (confirmed contributions not programmed yet) for the period in which the shortfalls occur then more credibility ought to be given to such conjecture.

To know which unprogrammed is available there are 3 key dates:

- *valid_from_date*: time from which the grant is available
- *valid_to_date*: time until when it is still possible to negotiate the grant even if the TOD already expired
- *TOD*: Terminal Obligation Date of the contribution which is stipulated by the donor (this date can be understood as the time until when all the commitments should be made i.e. purchase order for the commodities should be released on the system)

From the pipeline the following data pertaining to shortfalls occurred in 2015 was extracted:

Table 4: Shortfalls in value for implementation plan of project 200540

period	Shortfalls fcr	
01/01/2015	$	29,967.22
01/02/2015	$	29,967.22
01/03/2015	$	29,967.22
01/12/2015	$	263,873.72

The shortfalls depicted on the table since their period (time when commodities are required in the beneficiary country) has long expired constituted past pipeline breaks.

Having identified the shortfalls, one has to look at the resources available at the time.

Notwithstanding given that the file from where the unprogrammed is extracted is constantly updated, reflecting the usage of the grants with time, and that the shortfalls occurred a long time

[10] Report containing all the Donors contributions that haven't yet been used

ago, the only way to ascertain the existence of resources for that time is to look for grants without a TOD allocated to it i.e. they have no stipulated time until when they should be used.

Table 5: Available unprogrammed funds for Democratic Republic of Congo

funding_window	valid_from_date	TOD	unprogrammed_total
Multilateral	19/01/2011	31/12/9999	$ 23,062.06
Multilateral	15/05/2013	31/12/9999	$ 143,088.84
Directed Multilateral	19/11/2013	31/12/9999	$ 48,652.80
Multilateral	01/01/2014	31/12/9999	$ 203,183.75
Multilateral	01/03/2014	31/12/9999	$ 80,085.44
Advance	07/07/2014	31/12/9999	$ 719,408.84

For the calculation of the unprogrammed available for the transfer modality “FOOD” only the contribution type “cash” was considered.

For this purpose, the categories “IN-KIND” and “Not assigned” (category for which there was no clear consensus) were ignored.

As the data suggests for project 200540 there was 1,217481.73 USD that haven’t been used of which 48,652.80 USD are directed multilateral and 719,408.84 USD are released funds from the forecasted contributions, which could suppress at least one month of shortfalls that occurred in 2015 for the project mentioned.

Caution is always advised when making such assessments given the possibility of underlying constrictions that are not being considered.

Further exploration on the matter could only be done talking directly with some responsible for programming in the DRC.

Programming problem validation with South Sudan

Investigation proceeded this time for South Sudan, particularly for project 200859, in a timeline closer to the present date of the study. Data from a pipeline extracted on 12th of December and the unprogrammed funds on the 14th of December are depicted bellow:

Table 6: Shortfalls by commodity as for what needs to be resourced for January in the implementation plan

Commodities	Shortfalls [MT]	Shortfalls (fcr)
Iodised Salt	96.760475	$ 186,423.17
Plumpy Sup	183.58824	$ 881,210.41
Sorghum/Millet	4726.5985	$ 10,075,284.33
Split Peas - Yellow	635.26905	$ 1,543,715.34
Super Cereal Plus (CSB++)	1691.756	$ 4,830,702.38
Vegetable Oil	376.33378	$ 1,022,320.95
Total	7710.306045	$ 18,539,656.58

Table 7: Characterization of Shortfalls as for what needs to be distributed for January in the implementation plan

Commodities	Shortfalls [MT]	Shortfalls (fcr)
Iodised Salt	37.8882	$ 72,997.14
Plumpy Sup	50.04708	$ 240,222.40
Sorghum/Millet	2366.4045	$ 5,044,261.36
Split Peas - Yellow	224.8005	$ 546,269.30
Super Cereal Plus (CSB++)	678.054	$ 1,936,140.36
Vegetable Oil	33.62135	$ 91,333.31
Total	3390.81563	$ 7,931,223.88

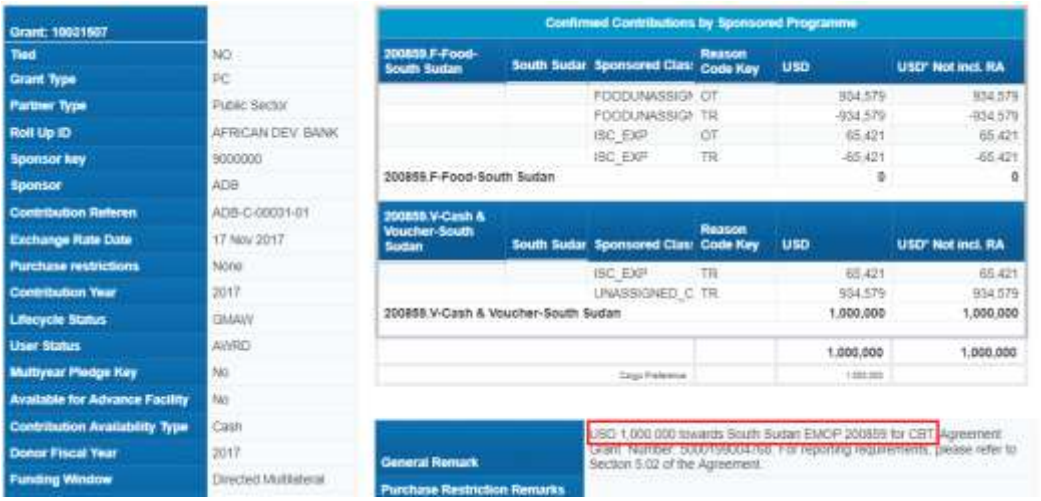
Table 8: available unprogrammed funds on the 14th of December

grant_number	funding_window	valid_from_date	TOD	unprogrammed_total
10030533	Directed Multilateral	19/06/2017	31/07/2018	$ 409.36
10030557	Directed Multilateral	10/04/2016	31/03/2018	$ 30,728,249.40
10031507	Directed Multilateral	17/11/2017	30/04/2018	$ 934,579.44

Given the information depicted in table 2, 3 and 4 one may be inclined to the conclusion that the commodities portrayed on the shortfalls for January 2018 could have been already programmed.

Again, one should be careful in such assessments since there may be underlying factors preventing the Country Office to use the above displayed resources.

One possible reason for not using the grants may be due to donor restrictions. To verify such conjecture given the grants having been released not too far away from the day when the study was conducted, information pertaining to Donor restrictions may still be available in an internal web platform from RMBP, Donor information hub[11].



Grant: 10031507	
Tied	NO
Grant Type	PC
Partner Type	Public Sector
Roll Up ID	AFRICAN DEV. BANK
Sponsor key	9000000
Sponsor	ADB
Contribution Referen	ADB-C-00031-01
Exchange Rate Date	17 Nov 2017
Purchase restrictions	None
Contribution Year	2017
Lifecycle Status	GMAW
User Status	AWRD
Multiyear Pledge Key	No
Available for Advance Facility	No
Contribution Availability Type	Cash
Donor Fiscal Year	2017
Funding Window	Directed Multilateral

Confirmed Contributions by Sponsored Programme

200859.F-Food-South Sudan	South Sudar	Sponsored Clas	Reason Code Key	USD	USD' Not incl. RA
		FOODUNASSIGN	OT	934,579	934,579
		FOODUNASSIGN	TR	-934,579	-934,579
		ISC_EXP	OT	65,421	65,421
		ISC_EXP	TR	-65,421	-65,421
200859.F-Food-South Sudan				0	0

200859.V-Cash & Voucher-South Sudan	South Sudar	Sponsored Clas	Reason Code Key	USD	USD' Not incl. RA
		ISC_EXP	TR	65,421	65,421
		UNASSIGNED_C	TR	934,579	934,579
200859.V-Cash & Voucher-South Sudan				1,000,000	1,000,000
				1,000,000	1,000,000

General Remark	USD 1,000,000 towards South Sudan EMOP 200859 for CBT Agreement Grant Number 5000159004766. For reporting requirements, please refer to Section 5.02 of the Agreement.
Purchase Restriction Remarks	

Figure 1 - Screenshot from Donors information hub

On the mentioned platform only information regarding grant number 10031507 was available. For this grant it can be seen that, despite pertaining to the transfer modality "FOOD" in the unprogrammed file, its use is constricted to the transfer modality CBT (Cash based transfer), which might explain why it hasn't been used yet.

It is thus suggested for the user while using the future warning system to always confirm if there is any Donor Restrictions that might hinder the use of the resources displayed.

It is also recommended for an additional column to be added in the report "Funds Unprogrammed" with a description of donor restrictions, in the case they exist, to concentrate information in one place.

A further note should be also given regarding South Sudan's shortfalls. In the above example there are two tables pertaining to shortfalls. One regarding shortfalls for what needs to be distributed the other one for what needs to be resources. These concepts will be explained in chapter 3.

[11] https://teamwork.wfp.org/03/04/DonorInformationHub/SitePages/Home%202.0.aspx

Funding problem validation

During the analysis of the requirements and shortfalls it was noticed that for many of the grants available for programming, the TODs were very close to the expiration date.

Example:

Table 9: Unprogrammed directed multilateral funds extracted on December 14th by country

Country	Grant number	valid_from_date	TOD	valid_to_date	Unprogrammed_total	
Central African Republic	10030592	16/06/2017	31/12/2017	31/12/2017	$	4,141,678.57
Cameroon	10030525	16/06/2017	31/12/2017	31/12/2017	$	1,034,649.53
Sudan	10029704	17/08/2015	31/12/2017	31/12/2017	$	495.20
Uganda	10030796	01/11/2016	31/12/2017	31/12/2017	$	13.56
South Sudan	10030557	10/04/2016	31/12/2017	31/12/2017	$	30,728,249.40
Ghana	10020678	01/01/2014	31/12/2017	31/12/2017	$	10,709.94

Given the relevance of the TOD and having in consideration that once it expires the grant is no longer available (in the case the *valid_to_date* is the same as the *TOD*) it becomes clear that a warning concerning their expiration ought to be incorporated in the warning system.

A warning that tells the Country Offices when will a grant expire so one can make use of it or renegotiate it with the donors e.g. for reallocation of the grant (see Chapter 3).

To know how should the warning system be designed and what it should incorporate the next chapter follows with the description and elaboration of the process flows concerned in the areas of the Supply Chain targeted.

The main information sources for this chapter elaboration were:

- Global Commodity Management Facility INFORMATION & INTERIM GUIDANCE NOTE
- WFP Budget and Programming Manual
- WFP Food Procurement Manual
- Staff Knowledge

3 Process flows in the Supply Chain

In the following chapter it is intended to:

- Know how the supply chain works (in particular we are interested in analysing all the processes that concern funding and programming)
- Understand how the warning system should be designed (through the comprehension of the processes involved)
- Who should be targeted by the system
- What data sources are available

The output of the following exercise besides what was previously stated will be the design of the swim lanes for the display of the process flows involved in the SC issues that are targeted by the warning system.

3.1 Implementation plan

WFP's projects start by the assessment of the situation in which a country finds itself. This assessment is used to infer the needs of the beneficiaries from where the requirements of a project are drawn, which will then be used for the elaboration of a project budget plan in a sequence as the one depicted in figure 12.

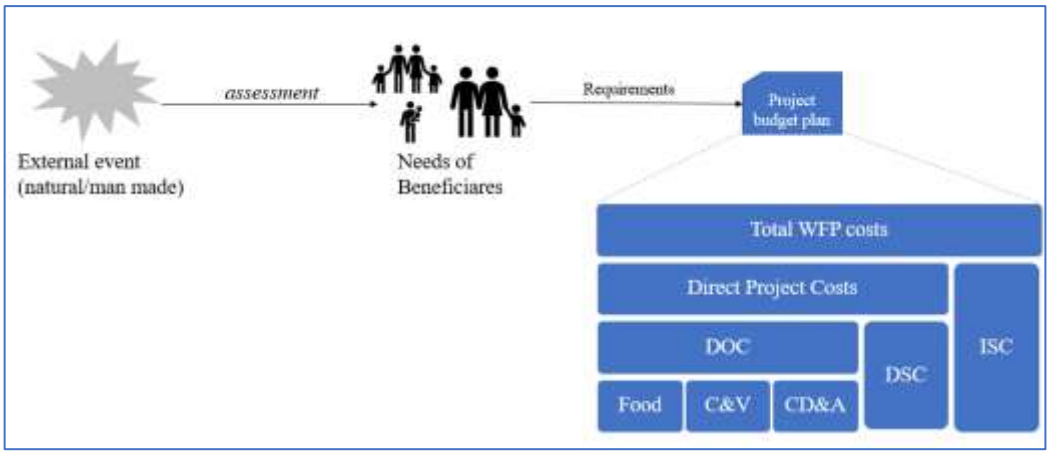


Figure 12: Sequence of events that proceed the elaboration of a project

The Project Budget Plan is the skeleton of a project. A tool to present detailed estimates of the requirements and related costs needed to implement a specific project. These costs are then converted into rates to estimate the full cost recovery when programming commodities (see funding chapter).

The costs involved in the provision of food to the beneficiaries are the ones as follows.

- Indirect support costs (ISC)
  Costs which supports the execution of projects and activities but cannot be directly linked with their implementation like Management & Administration (e.g. HQ programme support estimated as a percentage of the direct costs)
- Direct Support Costs (DSC)
  Costs which can be directly linked with the provision of support to an operation like Staff and Staff related
- Direct Operational Costs (DOC)
  Cost of commodities, ocean transportation and related costs, storage, etc…

The project budget plan does not however represent an actual budget that will be available to a project, rather it is a planning tool that is subject to resource/contribution availability.

Notwithstanding it reflects the needs of the targeted beneficiaries over the life of the project i.e. annual planned gross requirements.

The implementation plan is a plan derived from the project plan, which is prioritized and adjusted based on the funding forecasts and resource situations (for an easier comprehension please see figure 13). However, it does not replace the Project plan, which continues to be used to advocate for funds.

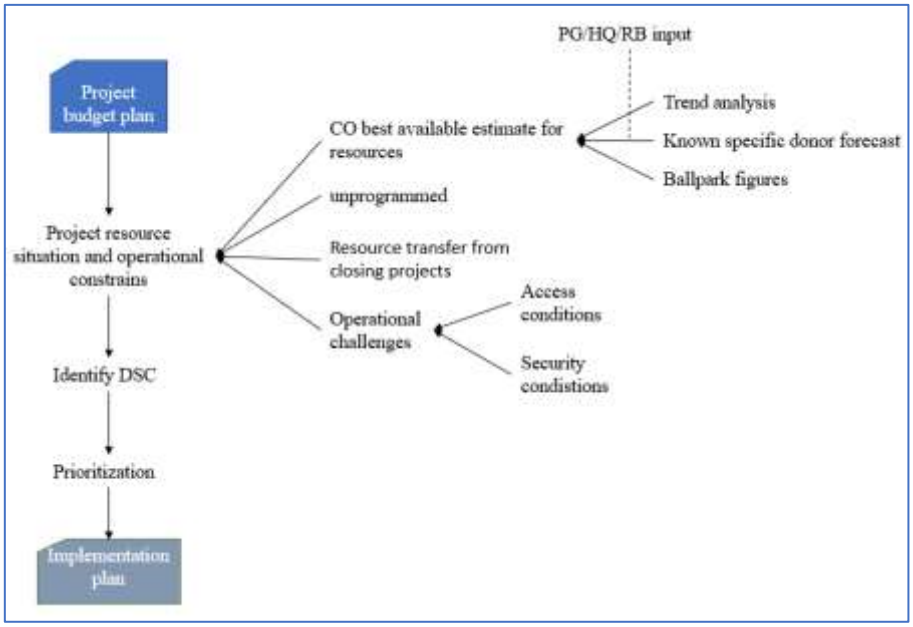


Figure 13: Steps involved between a project and an implementation plan

It enables to manage the gap between needs and contributions received which are often less than what was anticipated. It is also the plan used to manage the operations.

As the situation evolves through time so does the Project Budget Plan that is constantly updated on the basis of a needs assessment as figure 14 shows. On the other hand, the implementation plan is updated based on changes in the project income (actual and forecasts), capacity, constraints and changes in needs assessments.

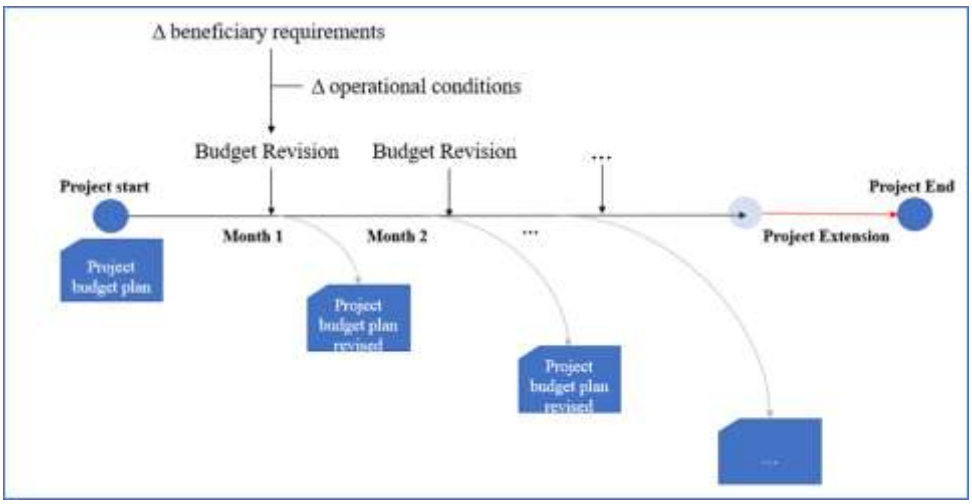


Figure 14: Evolution of a project through time

The programming warning should therefor capture this changes along a project's lifespan

Figure 15 can easily elucidate the reader about these 2 types of plans.

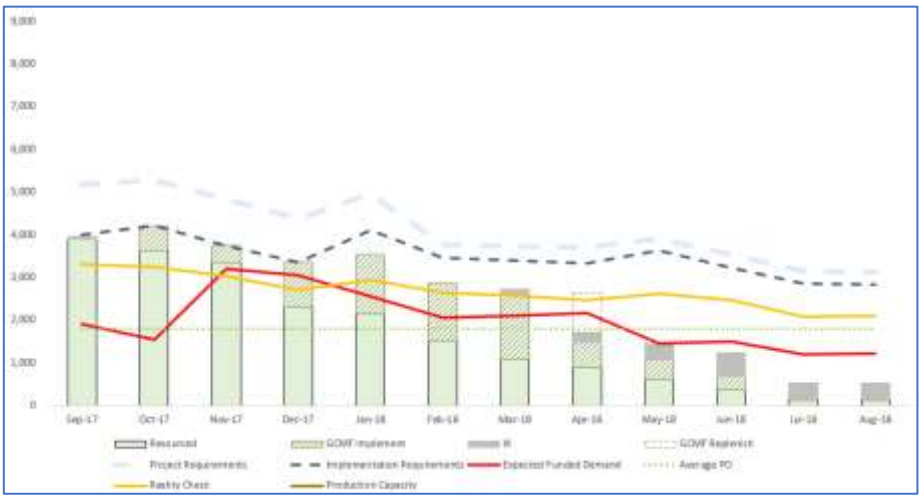


Figure 15: Supply against demand time series of a WFP's commodity (metric tons per month) taken from the Aug 17' global supply chain overview

In light blue one can see the project requirements in dark blue the implementation plan requirements and the green bars what was already resourced for each month.

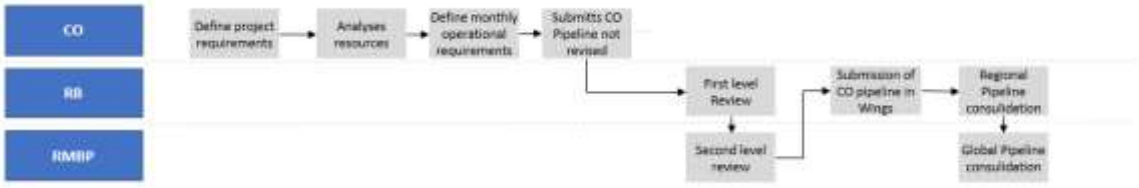
The distance between the implantation line and the green bars constitute the commodities' shortfalls.

Implementation projects are usually based on funding projections with a 12-18 months' time horizon based on forecasted resources.

3.2 Pipeline

Both the project and the implementation plan are communicated through the pipeline, a standardized Excel template, where project data and analysis are collected and compiled.

It is updated monthly having in consideration any ad-hoc changes such as the number of beneficiaries, operational constrains or resource reductions (ration downsizing, cancelled activities etc.), being then submitted for RB review and clearance.



All countries' pipelines are then aggregated under their RB and further consolidated by the RMBP in the Global pipeline.

The pipeline is a snapshot of the operation which is the basis for operational planning and decision-making reflecting what a CO plans to implement. It is with this tool that COs manage the actual food availability and a project's requirements and shortfalls.

These (requirements) can be for immediate distribution for a given month or for preposition.

Pre-positioning is many times required due to financial and operational factors (e.g. In Africa during the wet season many points become inaccessible, hence the commodities must be purchased and positioned in advance).

Figure 16:Depiction of the different types of requirements involved in a project's implementation

The sum of what needs to be acquired for pre-position and distribution for a particular month equals what needs to be resourced for that same month

Table 10: Practical example with different requirement types

Month	Preposition	Distributed	Resourced
Jan	20* [MT]	20 [MT]	40 [MT]
Feb	0 [MT]	20* [MT]	0 [MT]

In some cases, like in table 5, what needs to be resourced may be zero since the resources to be distributed come from a previous preposition exercise.

This means that during the project elaboration one needs to look to the shortfalls of what needs to be resourced for a certain month and not simply to what needs to be distributed, since if we look at what needs to be distributed we may be double counting resources and not counting with what needs to be acquired a priori for subsequent months, where accessibility conditions may compromise the acquisition of these same commodities.

In short, the commodities' shortfalls in a certain country for a given project can be understood as follows:

$$shortfalls = planned\ requirements\ ij - programmedfunds\ ij$$ [12]

$$planned\ requirements\ ij = distribution\ ij + preposition\ ij$$

Where:

$i = \{Jan, Feb, \dots, Dec\}$

$j = \{Maiz, Sorgum, \dots\}$

[12] Programmed funds correspond to the requirements for which financial resources have been allocated

3.3 GCMF

Before commencing with the description of the processes involved in the programming of commodities a note should be reserved for GCMF.

GCMF, Global Commodity Management Facility, formerly known as Forward Purchasing Facility (FPF), is a strategic platform within WFP.

Through its read-react capability uses a demand-driven global approach (i.e. pull system) to purchase food commodities in advance of programmes' needs and requests.

The basket of food that should be purchased in advance is estimated by RMBP[13], as suggested in figure 17, and concerns the countries that fall inside GCMF's planning zone[14] (a.k.a. sub-zone).

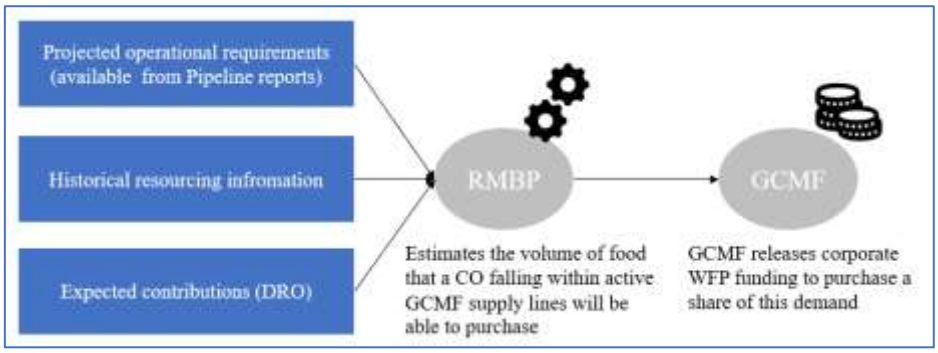


Figure 17: Framework on how does GCMF arrives to the quantities to purchase

This purchase is made for the entire planning zone and not the COs individually. Such management strategy is known as risk pooling and enables reduction of demand variability since a high demand from one country can be offset by the low demand of another.

The advantages of GCMF are threefold. It enables lead time reduction (when a CO purchases a certain commodity through GCMF at the time of the contribution confirmation the food will likely be already at an advanced stage in the procurement process), shorter emergency response and more affordable commodities since it purchases in large quantities at times when the market is favourable.

Information regarding GCMF available stock and sales to COs by sub-zone can be found in GCMF inventory report.

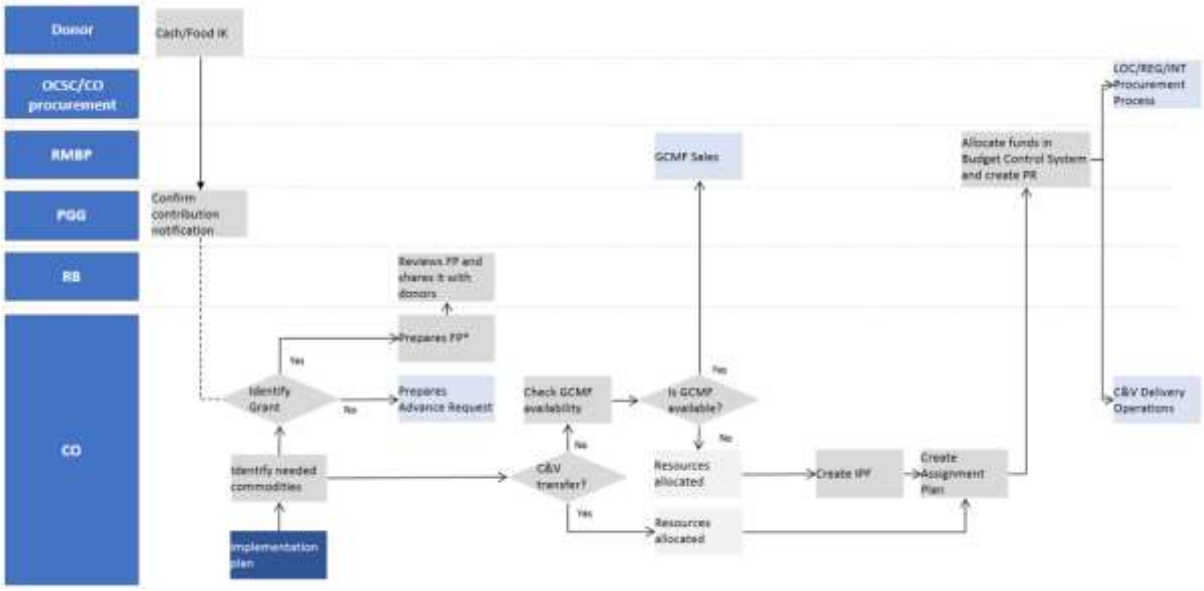
[13] The RMBP is overall responsible for budget related activities and policies related to the implementation of projects. Its services cover Programming, GCMF and pipeline/reporting.

[14] formed by a group of countries sharing similar logistic corridors.

3.4 Programming

Before requesting the programming of a commodity, a CO must ascertain the existence of resources to do so. Contributions have to be confirmed through the DRO focal point in the RB or through PGG. In case there are no contributions available a CO also has the possibility of resorting to Advance Financing (see Funding chapter)

In case there is a contribution available the CO starts the programming process by preparing a funding proposal (FP)[15]



After the FP being approved the CO should check GCMF for availability. If GCMF is available in the relevant logistic corridor, it should first be reviewed for available stocks as this is the primary source of commodities for projects.

If there are no GCMF stocks available, a CO should proceed with requesting the commodity procurement. The CO initiates the procurement process by firstly submitting an import parity form (IPF)[16] to Procurement for approval. After approval the CO then creates an Assignment Plan (AP)[17] and submits it to RMBP for review

Based on the AP, RMBP raises a PR to initiate the tendering process.

At the time of raising the PR, a budget for associated costs (LTSH, ODOC, DSC) is pre-programmed, meaning the funds are earmarked for the associated costs but not yet available for spending.

Following the PR release, we have the Procurement of the commodities process or, in case the transfer modality chosen to deliver the food is through cash or a voucher, which can then be used to purchase the same commodities in a local market, the C&V (cash and voucher) delivery operations process. Not being the latter a matter of concern in what respects the current project this last process is not going to be explored.

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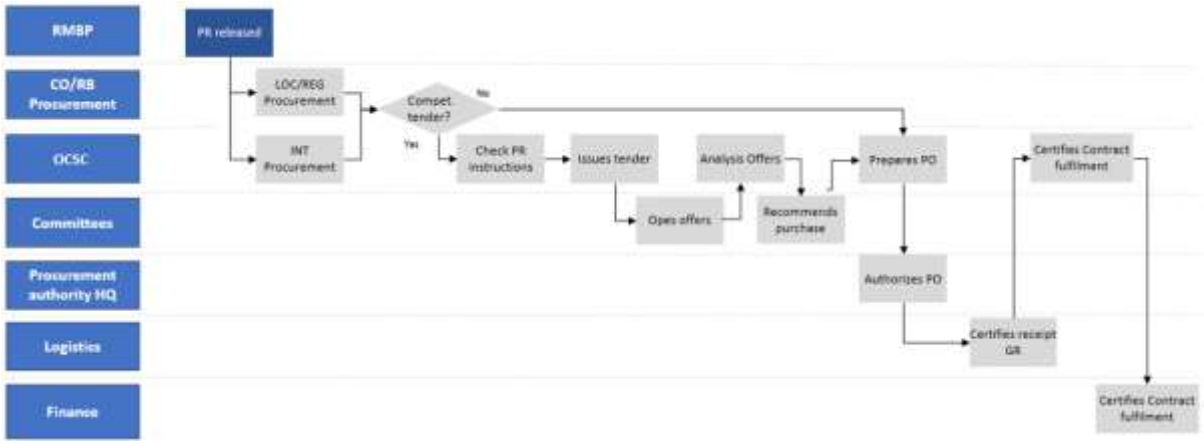
[15] FP reflects the proposed use of a contribution (in other words, commodity or CBT or CD&A and all associated costs for a given contribution) and which assure this contribution will meet Full Cost Recovery

[16] IPF is a file that contains all the relevant price comparisons, the constraints and the timelines used to compare food prices between international, regional and local markets (on FOB, FCA, etc. terms) considering transport costs, freight rates and lead time information for final purchase decision making.

[17] AP is a file containing all critical pieces of information which need to be taken into account when a contribution is programmed. It includes information such as commodity type, tonnage and cost, discharge ports and RTAs, C&V Transfer amounts and CD&A programming

3.5 Procurement

In case the commodity required is not available in GCMF stock the release of the PR on the system is used to initiate the tender



There are 3 types of procurement considered, as reflected in the flow chart:

- Local procurement (LOC)
  When the procurement is made inside the country
- Regional procurement (REG)
  When the procurement is made in different countries from the same administrative region (RB)
- International procurement (INT)
  When the procurement is made inside countries from different RBs or within the same RB but requiring shipping of commodities between ports

In any case WFP's general policy is to purchase through a competitive bidding process (competitive tender).

This type of tender understands a purchase from pre-qualified suppliers which entails an analysis of the cost of the commodity as well as the costs of transport and handling up to the delivery point.

For that some requirements ought to be observed:

- more than 3 offers
- no operational constrains or donor restrictions that would invalidate the process

Through this way it is ensured the practice of best prices and the transparency of the process.

As an exception, when the above requirements are not observed, direct tendering or waiver of competition is practiced, which must be previously authorized.

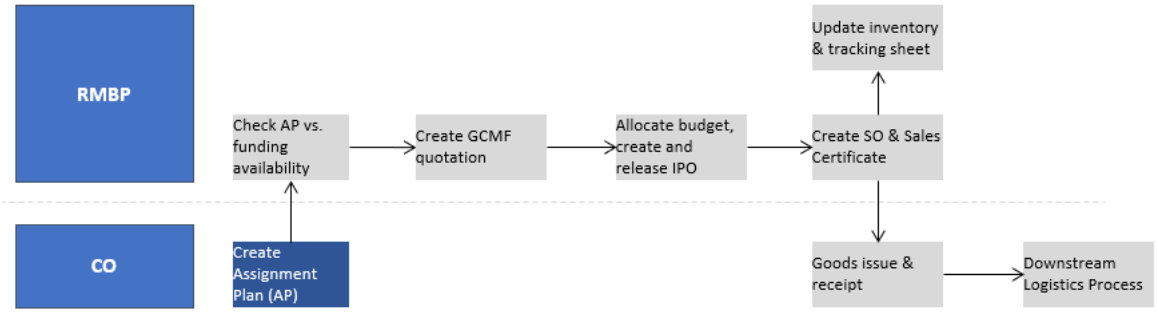
When the tendering process is completed and a food purchase order (PO) is released (meaning a contract has been signed for the purchase of the food), the pre-programmed budget for associated costs is posted and these funds are then available to the CO for spending/commitments.

The process then culminates in the reception of the food at the named delivery point designated in the contract made with the supplier (which will depend on the incoterm[18] used) and the release of a Goods Receipt (GR) note in LESS followed by the certification that the contract was fulfilled.

[18] See chapter for further explanation on incoterms

3.6 Purchasing through GCMF

In case commodity exists in GCMF inventory after the resources being allocated to the CO's project the RMBP releases the IPO (internal Purchase order) which is the same as a normal purchase order but intended to buy a portion of GCMF's inventory.



Afterwards a Sales order is created against the IPO and the commodities are shipped from the GCMF facility.

Once the goods are received by the Country office in a named delivery point the CO proceeds with the distribution process to the beneficiaries.

3.7 Funding

WFP relies entirely on voluntary contributions for its funding.

Contributions are received from governments, inter-governmental organizations/ inter-agency arrangements, multi-donor funds and private companies or individuals.

Donors provide contribute to WFP through three funding windows:

a) Multilateral i.e. The funds donated are not directed by the donor to specific country projects, but may in certain cases have allocation restrictions in terms of program category
b) Directed Multilateral i.e. The funds donated are directed by donor to specific country programs or projects
c) Bilateral i.e. The funds donated are directed by donor to an activity non-initiated by WFP

Besides confirmed funding contributions, and to streamline the process of decision making, if a CO needs funds to get its project started, but doesn't have any contributions confirmed yet, it can resort to Advance Financing mechanisms (AF).

AF is basically a financing mechanism through which funds to a project are provided in anticipation of contributions (forecasts) being confirmed.

The Primary forecasting technique is a qualitative approach that is based on the opinions of the Donor Relations Officers (DROs) which have continual contact with donors allowing them to note any change in donor preferences or behaviour instantly.

Forecast contributions are currently categorized as high, medium or low probability when inserted in WINGS.

The advance made can go until 80% of the forecast contributions depending on the probability.

The advances available from the forecasted contributions can be found on WINGS in the Forecasted and Confirmed Allocation Report.

As was noticed during the analysis of such report only forecasted contributions with high probability are considered for use, aspect this that should be considered when building the alerts.

Once the contributions are confirmed the advance should be repaid.

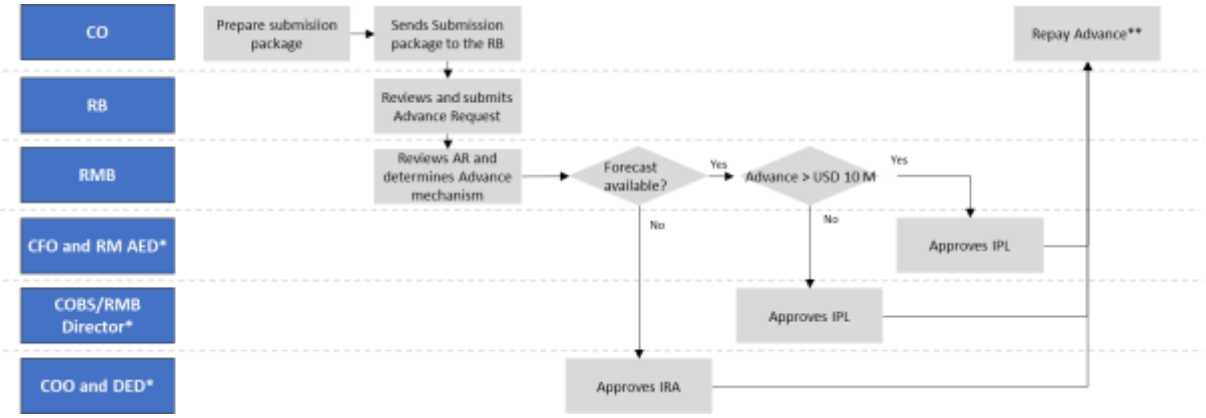
There are 2 mechanisms of AF:

Internal project Lending (IPL) or Immediate response account (IRA).

IPL is a mechanism through which financing is provided to operations on the basis of forecasted contributions when a project is in need of immediate funding. It is used to reduce the time between a donor expressing interest in contributing to an operation and the contribution being confirmed.

When the IPL is unavailable due to a lack of forecasted contributions, or when forecasted contributions are not sufficient to qualify as collateral one can resort to the IRA. It can fund up to three months of initial requirements in an EMOP or SOP, or, in exceptional cases, it may be used to react swiftly to a sudden change in the circumstances of an ongoing EMOP or PRRO (see chapter 1).

The following swim lane covers the processes involved from preparing an AF request to the repayment of the loan.



*IPL advances less than 5 million are approved by the Chief of Organizational Budgeting Services/ IPL advances between 5 million and 10 million are approved by the Director of RMB/ IPL advances above 10 million are approved by the CFO and the RM AED with endorsement from SRAC

**There is the possibility for a contribution forecast used as collateral to fall through in which case other eligible forecasted contributions will have to be identified

When the CO first notices that there are no contributions available yet, it first submits an AF request to the RB. The RB, after a first review, submits the request to RMB (of which RMBP is part), which will be entitled with determining which mechanism to use. Once the mechanism is determined and the advance is approved it gets released for the use of the country office, which can be seen in the Forecasted and Confirmed Allocation Report. Once the contributions are confirmed (in case of an IPL) the loan gets repaid. In the case of an IRA other contributions ought to be used to repay.

When considering an AF the CO should check beforehand for unprogrammed contributions (already mentioned in chapter 2). The path taken for the selection of the funding mechanism can be further elucidated through figure 18.

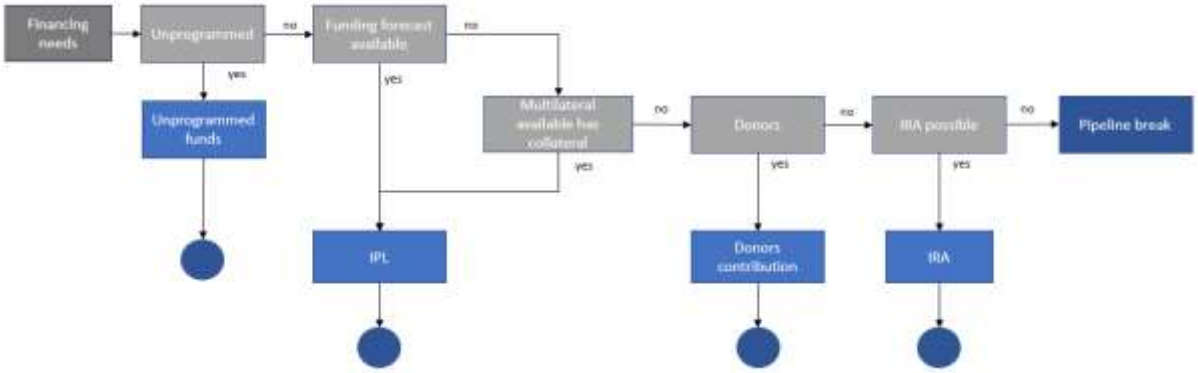


Figure 18: Framework for the selection of the financing mechanism to be employed

If there are contributions' forecasts available, the project can apply for lending. There is also the possibility to use Multilateral as collateral instead of a forecast (which are made available by RMBP following SRAC approval). In case no collateral is available the CO can still try to appeal to its donors for more contributions and in serious cases, if the situation justifies, the CO can also resort to the emergency account (IRA).

If none of the mentioned financing mechanisms are possible then the CO should expect a pipeline break for which a reconfiguring of the food basket composition should be done so the shortage as the least impact possible.

An additional note should be made regarding the programming of the funds:

When programming funds, WFP follows a Full Cost Recovery policy (FCR). Full Cost Recovery is the principle that each contribution must fully cover its own costs in moving, managing and monitoring the contribution i.e. all contributions should come with sufficient cash to accompany the full associated operational, direct and indirect support costs, that way ensuring solvency for WFP's operations (meet its long term financial obligations).

3.8 Commodity Loan and Borrowing

There is a second way a country can get the resources it needs into its operations besides the use of liquidity (Donor contributions or AF) or In-kind food.

Such can be achieved through moving contributions between projects such as:

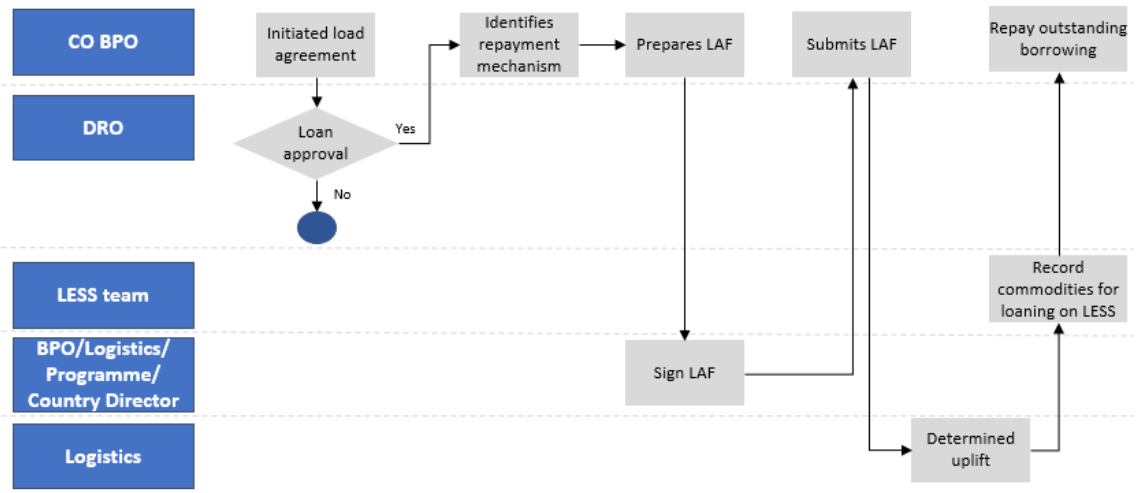
- Reallocating grants
- Refinancing
- Commodity loans and borrowings

Refinancing is a complicated process that involves moving actualised expenditures from one grant to another for what is only seen as a last option.

Reallocating grants is a technically slow and complicated process that entails the permanent moving of a grant from one project to another.

For the reasons above mentioned these methods are going to be discarded in the conceptualization of the alert system.

A commodity loan or borrowing (as mentioned in chapter 2) happens when commodities from a WFP project is loaned to another operation with the agreement for it to be later repaid[19].



Commodities expiring in neighbouring countries will be depicted in the programming warning. This means that upon the CO programming officer going to the alert system, to check what commodities should start to be programmed, he/she can have an immediate picture of what commodities, needed for her/his project, are expiring in neighbouring countries.
In case there is a match the CO can submit a Loan and agreement form after the approval by the DRO (that checks with the donors for their approval).
The Loan is then signed by the competent entities, passing through the country's Logistics department and being registered on LESS to be latter repaid.

This proposed methodology will also help improving the "*$ and MT change in food losses due to expired best before date*" KPI (present in the document "*SC – PERFORMANCE INDICATORS (FOOD)*" (2017) under the Asset management efficiency section), which reports on changes in food losses from the previous to the subsequent year.

[19] Loan agreement form is a document with information regarding the quantity to be loaned, the repayment mechanism and period when loan repayment is scheduled

3.9 Lead times

One of the key ingredient for the success of the warning (programming and funding) lies on the correct estimation of the lead times, which for the case of a humanitarian supply chain can constitute a considerable problem.

The lead times can vary due to unforeseen factors such as a corridor that suddenly gets blocked, roads with bad accessibilities, or due to concrete and relatively measurable factors such as the type of procurement (e.g. if the commodity comes from a different administrative region or requires movement of cargo between ports, it is expected for the lead times to be longer).

In this chapter it is intended to get to know:

- Which lead times are involved in the supply chain process
- How does the system captures the lead times
- What milestones are used to measure these lead times

The above objectives were reached thanks to WFP staff's knowledge and through the analysis of the file "Business Blue Print, LESS Reporting Solution, Version 0.02" elaborated during the transition of the previous commodity tracking system, COMPASS, to LESS.

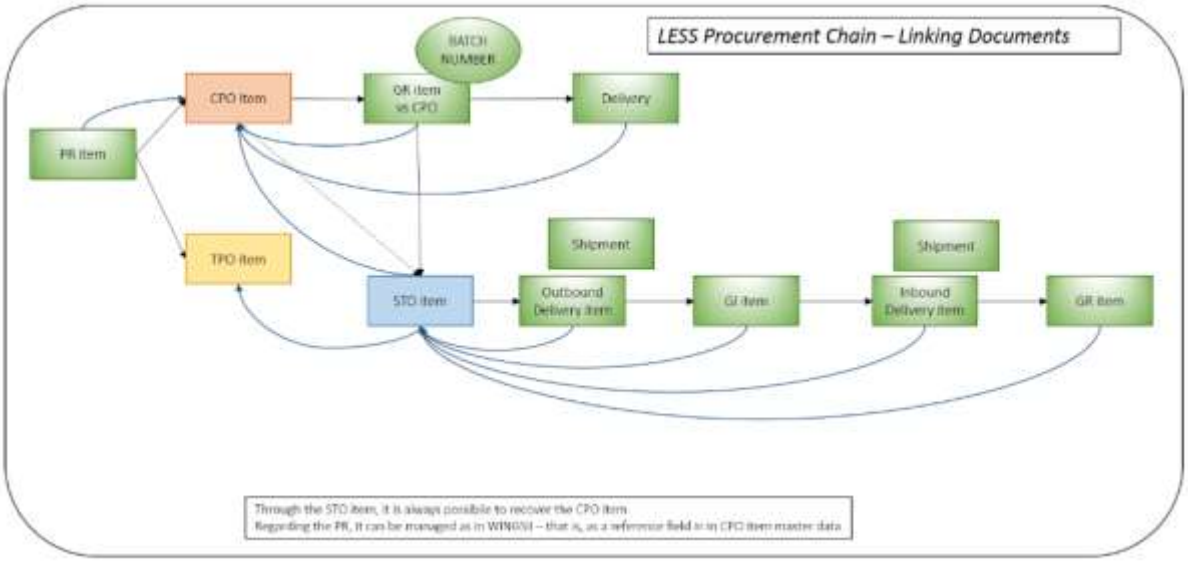


Figure 19: LESS objects pertaining to the movement of commodities

When a CO needs a certain commodity, it releases a PR (Purchase Request) on the system (LESS). Once the supplier is selected a PR is converted into a PO/CPO (Purchase Order/ Commodity Purchase Order) which is used to purchase food to the Supplier. The PR is also the trigger for the creation of the TPO (Transport Purchase Order) to buy services for the transport of food to a NDP (named delivery place) which will depend on the incoterm used.

Once the Commodity arrives to the NDP a GR (Goods Received) item is created.

This first part can be found documented in the PR and the PO file, being the PO number item connected to the PR number item in the PO file.

Since every food carrier must be accompanied by a Waybill/Shipment note, the CPO (which indicates the quantity purchased) can be checked against the Waybill.

Once the food is in possession of WFP an STO item is created. It tracks the transfer of commodities from the original point where food was received from the vendor to the warehouse of destination in the country project

The STO will then contain the reference to the TPO and CPO items.

Once the commodity leaves the WH where it was first received by WFP an outbound item, containing the information of the BoL[20] (Bill of lading), and a GI (Goods issued) element are created on the system, meaning the good is in transit. When the food arrives an inbound item and a GR item are created.

A derived CPO and a TPO are always created whenever movement of commodities between nodes of the logistics network are observed.

All the movements of commodities can be currently found in the CTR (Consolidation Transport Report) which results from the aggregation of the Vessel discharge (pertaining to the movement between ports) report and the Dispatch report (not pertaining to the movement between ports).

From this exercise it becomes clear how does the system works as well as which dates are used to calculate the lead times, and from which documents these (dates) can be extracted (see figure 20).

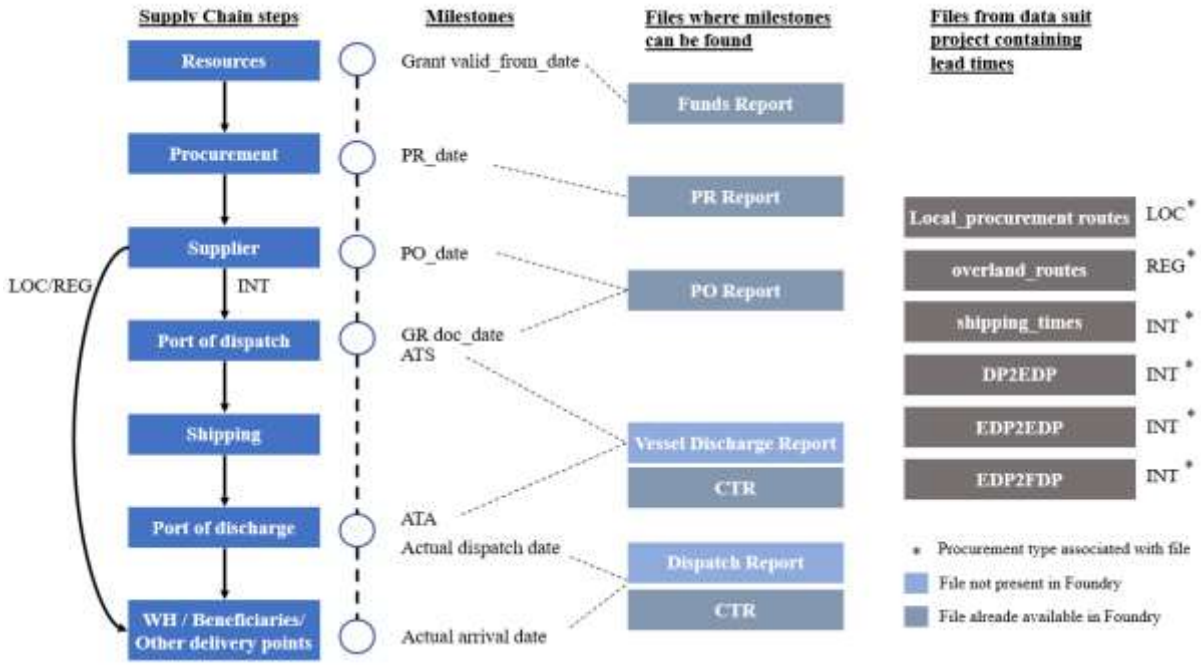


Figure 20: Files available for Lead times estimation

The total lead time associated with a commodity from the time a request for it is raised until the place where it is delivered can be understood as the time elapsed between a PR (purchase request) until the commodity arrives at its destination in the beneficiary country.

Since in the pipeline there is no delivery point defined, the first entry point in a country, whether it be a Warehouse or a Country partner, was considered as the final point of the supply chain lead time.

[20] The BoL is a document issued to acknowledge that a carrier received the cargo for shipment (https://www.investopedia.com/terms/b/billoflading.asp)

In the analysis of the lead times made 2 types were defined (see Milestones in figure 20):

- Procedural lead times
  i.e. don't pertain to the processes of movement of cargo (all the activities before the PO being released on the system)
- Dynamic lead times
  i.e. lead times that concern the movement of cargo (from the PO onwards)

The project in regard to the lead times was first started by the statistical analysis of the same after establishing the path that connects the several documents and the cleansing of these for outliers (See attachment E). This approach was abandoned in the end in what concerns the dynamic lead times given the latest developments in the data suit project (see figure 20 right column).

What was still lacking, in what concerns lead times, in the data suit files, were the procedural ones. For these a statistical analysis in the software Minitab was carried.

The methodology involved in their estimation can be seen in Attachment F.

The methodology starts by making a conjecture about the factors that may influence the procedural lead times (inferred by the analysis of the procurement process flow)

Given that the results were inconclusive a rule of thumb of 10 days (median of the lead time for the case of a competitive tender) was assumed for the time elapsed from the moment a PR is released on the system until the PO.

The reason is twofold:

- Due to time constrains of the Project it is intended to capture the lead time at a global level
- The median, having a lower breaking point, constitutes a better option to the average in the presence of skewed data

4 Solution description

4.1 The concept of a Warning system

Whatever the problem a Country Office may be faced with, many times there is still a window of opportunity to take action that might be overlooked if no mechanism is in place to warn about it.

Such window can be defined based on estimations about time (e.g. the lead time of a certain process from A to B) or capacity (e.g. capacity of a certain element in the SC such as a port or a supplier)

Existing literature only looks over warning systems concerning natural hazards (Alfieri et al. 2012) and (Coughlan de Perez et al. 2015).

Even though the concept of a natural disaster's warning system is different from the scenario of the project (warnings concerning Supply chain issues) conceptually there are some similarities in that both concern the estimation/prediction of events and have the objective of warning entities about those same estimations.

Given this premise there are a key set of components, that must be observed in a natural disaster's warning system for it to become operational that can be adopted in a Supply Chain's warning system. Such components described in (Coughlan de Perez et al. 2015) can be transposed for the present case.

- Relevant early warning information available
- Opportunity for early action
- Designated entities responsible for taking early action

As for relevant early warning information it is understood information that enables to reach assumptions about the object under the scope of the warning. For the case of a commodities programming warning it concerns information about shortfalls for a given country and SC lead times (time it takes for the commodities to reach the destination country).

This information would only be useful if there is opportunity for early action. In the case if there are resources available to proceed with the programming of the shortfalls (e.g. unprogrammed and/or funding forecasts available as collateral).

In the present case it would also be useful to warn a country about the need to programme a certain commodity even without resources. That way awareness is raised for the need to get funding.

Finally, to materialize the action, it must be clear who would be responsible for making the decision, given the information of the warning system and the resources in place.

Having the information and the recipients (responsible to take the action) the system releases the warning after a certain threshold has been reached.

Different warnings, concerning time or capacity, will have therefor different thresholds that should be met for the warning to be released.

The warning is presented in a platform of the software Foundry (see next chapter) and was conceptualized for the use of the Country Offices.

The result pretended with such system is to observe more of the projects' implementation requirements to be met, hence contributing to the overall humanitarian supply chain motto of "Right people, equipment and material, in the right place, in the right sequence as soon as possible, to deliver the maximum relief at the least cost" (Gyöngyi & M., 2007).

4.2 Innovative approach

Data integration can be seen as a fairly hard problem for any organization, which is especially true for WFP, given the fact that it has multiple data sources and systems.

Sources can contain closely related and overlapping data (the most glaring example being the country names that may be different in different systems e.g. in WINGS Syria is Syrian Arab Republic whilst in LESS it is referred only as Syria) differing in query processing capabilities as well as data that can be stored in multiple models and schemas (Levy 2000).

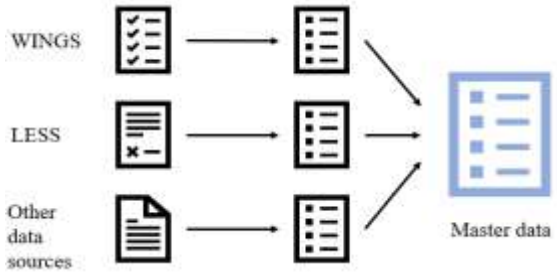


Figure 21: Framework of the data suit project

With the purpose of making cross-functional data accessible by anyone the development stream of the planning service unit has recently initiated the data suit project (Figure 21).

The project aims to collect all information, integrating it into a unified database where master data is aligned and available in one single place, hence avoiding related overlapping data.

To help with that Palantir technologies emerge. [21]

Palantir technologies is a software and services company specialized in big data analysis. Its main products are the platforms Gotham and Foundry.

It is over the latter the alert is going to be conceptualized.

Foundry's core is data integration[22], enabling anyone to source, fuse and transform data into any shape desired.

In Foundry through a pluggable Extraction & Transformation framework[23] data from any source (WINGS, LESS and other WFP data systems) can be imported Payne et al. (2008).

[21] https://www.palantir.com/palantir-foundry/

[22] data integration consists on combining data that spans from different sources with the aim of providing the user with a unified view of the data Lenzerini (2002)

[23] data extraction comprehends the extraction from homogeneous or heterogeneous data sources (i.e. data sources that use the same data base management system or not) while data extraction the transformation of data for storing in a proper format or structuring of data with the aim of querying or analysing it

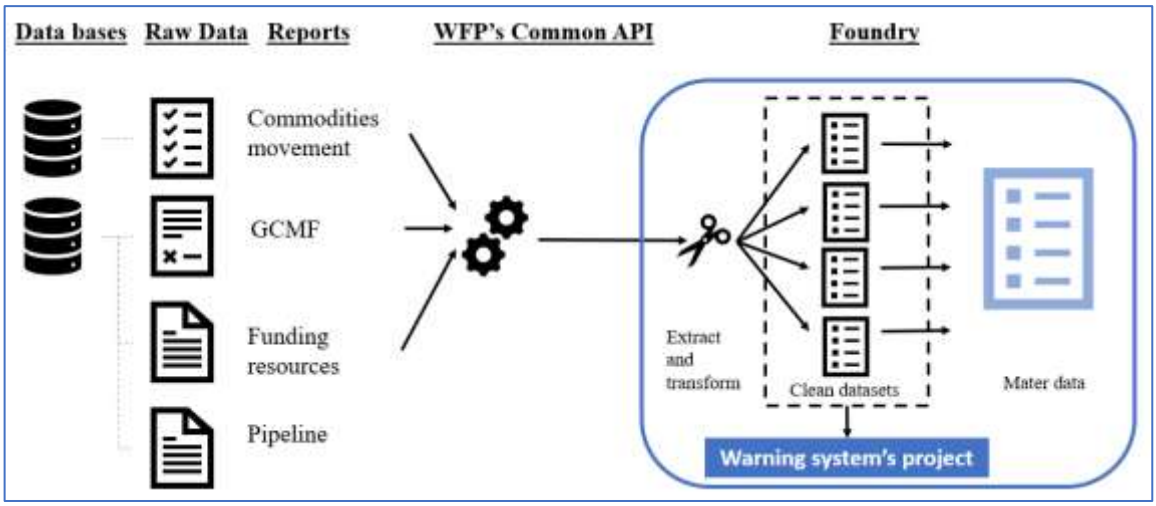


Figure 22: Scheme exemplifying how data is captured into foundry

This ability to import raw data (structured and unstructured) is achieved via application of programming interfaces (API's)[24] , in the present case WFP's Common API, that facilitates the provision of source data updates for Foundry.

Such agility enables much easier analysis, collaboration and extraction of knowledge within the organization.

Every end product created through the software, like the tables resulting from an SQL transformation, later described, becomes a new data source over which one can build upon.

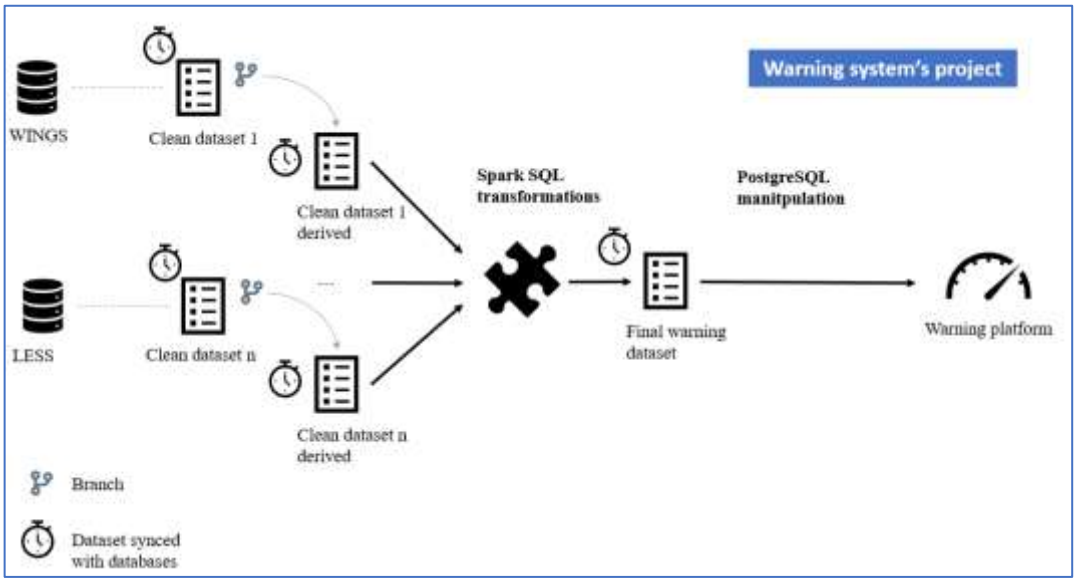


Figure 23:Methodology employed to get to the warning system

Hence the software is going to be used to extract some data necessary to the warning's system functioning already available for the data suit project.

[24] API's are tools, which can be understood as a set of commands and their format, used with the purpose of sharing content and data between software applications (https://libraries.mit.edu/scholarly/publishing/apis-for-scholarly-resources/)

For the remaining data that may not be already available, the project is going to resort to the manual uploading of the same with the prospect of it to be integrated in the data suit project[25].

For the datasets available from the data suit project and to ensure that the alarm functions properly and does not get changed whenever someone changes the ancient dataset, these are going to get "branched" (figure 23). A branch can be seen as a clone of the original dataset from which it is derived, that like its parent (dataset) remains in sync with the database (from which the ancient dataset originally provides). At the same time, as a branch, it can only be modified by the person creating it i.e. if the person that created the ancient dataset modifies it, such changes will not be reflected on the created "branched" dataset.

After reaching the final dataset through branching and SQL transformations the warning is going to be programmed inside a Foundry's module called Slate.

In this module by resorting to PostgreSQL, through queries one can call the elements of the final dataset containing the information to feed the warning (achieved through the SQL transformations) after this being uploaded on the module. This module will then have widgets, like dropdown lists and Gantt diagrams that are fed with the final dataset information by calling the query used to call its elements.

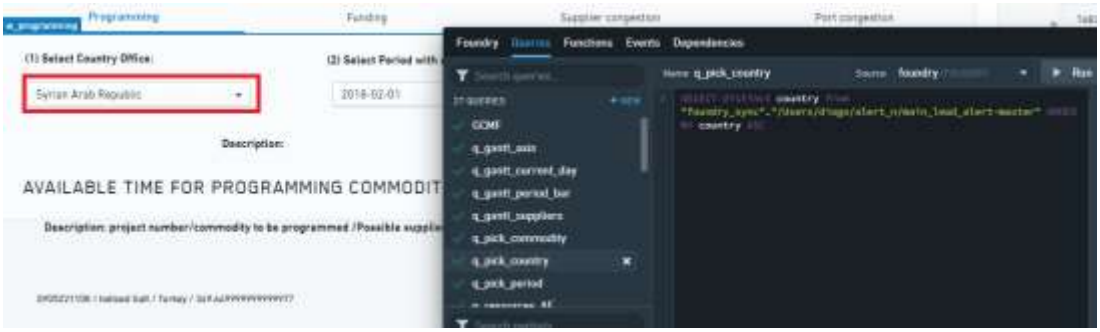


Figure 24: Example of query to call dataset elements

Figure 25: Calling a query to program a dropdown list widget

In Figure 24 one can see the employment of a query to call the countries with shortfalls present in the final dataset of the commodities' programming warning.

These countries are then presented in the dropdown list by calling the query in the list data source as depicted in figure 25.

[25] While that doesn't happen every data upload has to be manually done in Foundry

The use of this upcoming technological solution to the creation of the warning system will fulfil some of the requirements of the project namely:

- **Cross-functional collaboration**
  Every member from WFP has access to Palantir through the internal account, which means the tool is deployable in every CO.
- **Getting the full picture**
  The tool covers processes from funding to programming.
- **Anticipation**
  The tool will help contribute to the mandate of the planning service in mitigating risk in the supply chain not only through the visibility the tool brings but also by anticipation of problems (e.g. telling the CO in advance to programme the commodities so pipeline breaks can be avoided)
- **Innovation**
  Levering on innovative technologies, whose purpose was to contribute to the data suit project, to create a warning system.

4.3 Final set of alerts

From the alerts to be portrayed on the system, that resulted from the exercise described on chapter 2.2.1 (pg. 17 table 3), and after analysing the processes of the supply chain, follows a description concerning who should be targeted by such system and what it is pretended with each of them (see table 10).

Table 11: Alerts description

Programming alert **Subject targeted:** **CO programming officer**	**AS-IS:** Programming of commodities are based on experience and communication between CO departments
	TO-BE: Programming of commodities more methodical and based on systems intelligence. On-time communication of funding needs
	Warning: "Limit date to programme the commodities was reached"
	Expected improvements: Improvement on the perfect order rate due to the impact of the alert on delivery on time
Funding alert **Subject targeted:** **CO programming officer**	**AS-IS:** Use of grants as necessity arises not considering time of expiration
	TO-BE: Use of grants considering time of expiration
	Warning: "Limit date to programme the grant was reached"
	Expected improvements: Better use and awareness of financial resources
Port Congestion alert **Subject targeted:** **CO programming officer** **OSCS staff member**	**AS-IS:** No consideration about future port congestion during procurement
	TO-BE: Consideration of future port congestion during procurement process
	Warning: "Port abc is going to be congested"
	Expected improvements: Better preparedness of the CO and OSCS knowing the port is going to be congested and commodities may arrive late. More visibility for the use of alternative routes
Supplier Congestion alert **Subject targeted:** **CO procurement officer**	**AS-IS:** No consideration of future supplier congestion
	TO-BE: Consideration of future supplier congestion when programming commodities
	Warning: "Supplier capacity completely fulfilled until a certain date"
	Expected improvements: Better planning regarding commodities programming when considering suppliers More visibility to supplier's capacity

5 Platform conceptualization

For the conceptualization of the warning system the same methodology as the one described in a systems development life cycle model (SDLC) is going to be employed. Even though there are many derivations of the model the one regarded in the present case will be the general basic model (Ragunath et. al 2010), a waterfall approach that can be summarized in the following steps as suggested by figure 26:

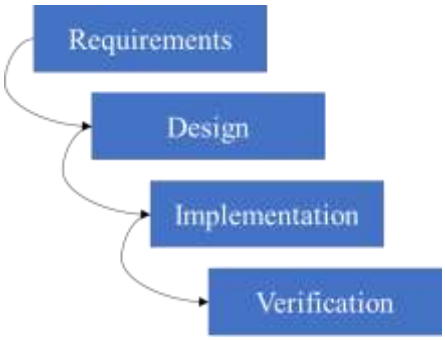


Figure 26:Waterfall approach for the platform's development

- Requirement
  Description of the product/ system behaviour/ use cases/ interaction between user and product
- Design
  Create the specification of the software architecture/Low-level algorithm and architecture design/ Maintainability
- Implementation
  Coding based on the design
- Verification
  Testing of the procedure development

The approach chosen has little flexibility, doesn't allow for the production of a platform's prototype until late in the life of the project and has the big inconvenient that some change during the life-cycle of the project might kill the own project.

Despite so many reasons opposed to its use it was still chosen for the following reasons:

- Simple and easy to use
- Easy to manage due to its own rigidity
- Good choice when time is a big constrain and requirements are well understood
- Works well for smaller projects

Also, due to Foundry's own architecture and the way the platform was designed posterior changes can still be implemented.

5.1 Requirements

The system will enable the decision-making processes concerning the problems targeted by the platform to shift from passive, where the decision maker gets overloaded with problems and has no clear information about when to take a certain action, to a proactive process of decision that, bringing visibility to the problem (e.g. time to program commodities is expiring), will help her/him be more time accurate about when to act (e.g. decision maker initiates commodities programming because time limit estimated to do so was reached).

The system can be understood in the following premises:

1. The system will be a platform with key alerts for problematic areas such as On-time delivery, Funding, Supplier Congestion and Ports Congestion
2. The Subject that deals with the problematic areas will be warned about possible issues that may require attention now to avoid future problems

The system can be further elucidated through the following use case diagram in figure 27:

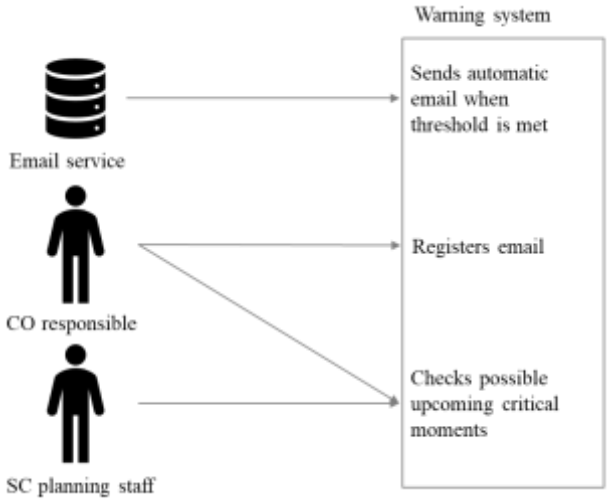


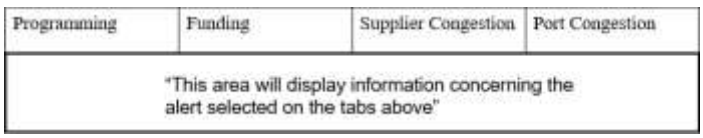
Figura 27: Use case diagram

The user will take 2 actions on the system. It will register its email and check for critical situations in the supply chain regarding programming, funding, supplier and ports congestion.

The system will then send a warning message whenever a threshold is met.

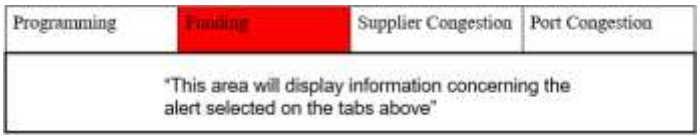
When the CO responsible goes to the platform the following situations can be found:

Situation 1 representation:



Situation 1 description: User goes to the platform and no logo is red i.e. no putative critical situation captured by the system

Situation 2 representation:



Situation 2 description: User goes to the platform and one or more logos is red i.e. putative critical situation captured by the system that will require some action

When the system finds itself in situation 2 and if the time or capacity limit (threshold) of a certain process is reached (e.g. after a certain day the commodities are going to arrive late or after a certain port capacity usage, congestions is inevitable) the system will automatically trigger a warning (email) to the responsible entity defined in table 10 under “Subject targeted”.

Table 12: Threshold by process concerned in the warning

Warning	**Threshold**
Programming	today = period when commodities are needed - estimated lead time from PR to first entry point in the country
Funding	today = TOD date - estimated lead time from PR to PO
Supplier Congestion	To be defined
Port Congestion	Port capacity usage for a certain month = 80%

Table 11 describes the thresholds defined for each alert. For the commodities programming it was established as the day after which, given the historical lead time, the commodity will no longer arrive on time. For the funding the time it takes on average to release the purchase order in the system. And for the Port Congestion when the estimated used capacity of the port, calculated based on upcoming orders, reaches 80%.

The following chapter in what concerns design and implementation will only address the programming warning given that the same procedures were applied to the remaining ones. Only a small remark will be left to the port congestion warning.

5.2 Design

Commodities' programming warning

Figure 28 depicts the steps employed to reach the dataset used to program the commodities' programming alert on slate.

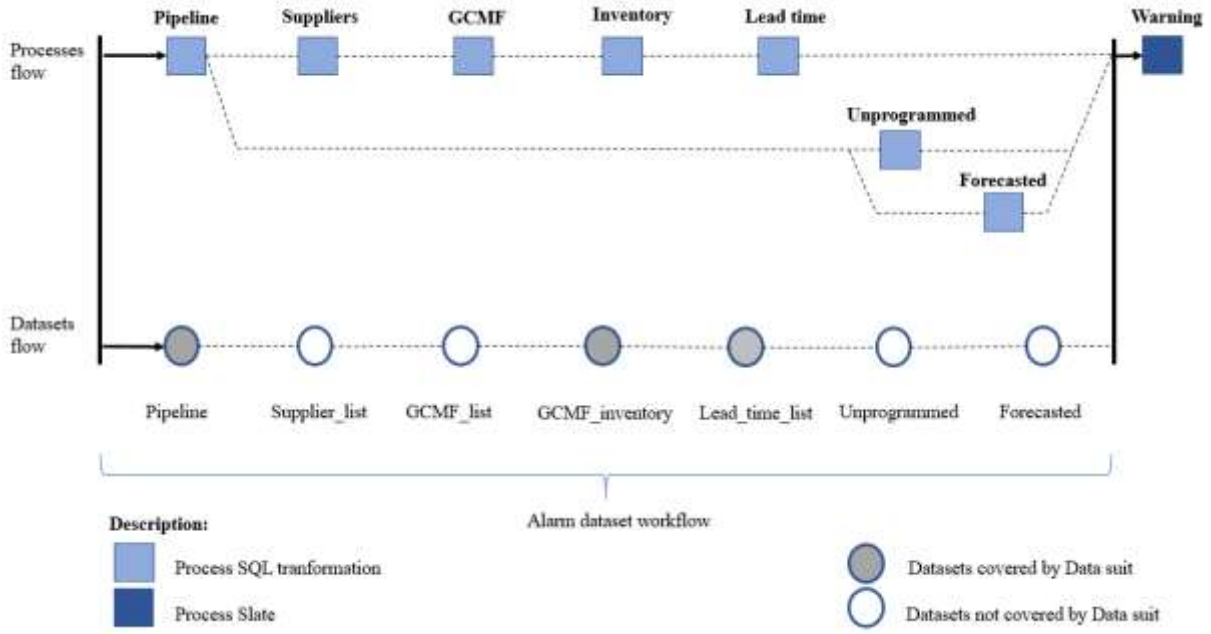


Figure 28: Programming warning design's framework

In the framework one can see the Processes (Processes flow) that correspond to a set of SQL transformations of the datasets depicted in the Datasets flow.

The 2 flows mentioned constitute the "alarm dataset workflow" used to reach the final dataset that is going to be employed in the construction of the programming warning on Slate (process "Warning" in figure 28) mentioned on chapter 4.2.

Since each process is embedded in the next some caution is required. Attention should be given to assure that the nomenclature used in a certain file corresponds to the one that proceeds (see example mentioned in overlapping information concerning data integration described in chapter 4.2).

Regarding the datasets presented in the datasets flow of figure 28, table 12 summarizes what can be found in each of them, as well as the ancestor file in the system from which the datasets are derived and the frequency with which they ought to be updated.

Table 13: Datasets used for the programming warning

Data set	Description	Origin file (System)	Extraction
Pipeline	Information regarding the shortfalls of what needs to be resourced for a certain month as per the implementation plan	Pipeline (WINGS)	Extraction through the common API (automatic)
Supplier_list	List of possible suppliers for Normal procurement for a certain commodity given the beneficiary country	PO report (LESS)	To be defined
GCMF_list	List of GCMF sub-zones for the beneficiary countries targeted	Global GCMF inventory report (LESS)	Yearly extraction according to GCMF strategic demand plan
GCMF_inventory	Available $[MT]$ in-stock in a certain GCMF sub-zone for a certain commodity given the beneficiary country	Global GCMF inventory report (LESS)	In the future extracted through the common API (automatic)
Lead_time_list	Estimated Lead times for a certain Supplier given the beneficiary country	PO report (LESS) Consolidated Transport Report (LESS)	Extraction through the common API (automatic)
Unprogrammed	Available resources still not programmed	Funds Unprogrammed Report (WINGS)	In the future extracted through the common API (automatic)
Forecasted	Forecasted available for AF still not earmarked	Forecasted and Confirmed Allocation Report (WINGS)	In the future extracted through the common API (automatic)

Figure 28 describes how are the datasets worked on (transformations employed) and their logic sequence in the conceptualization of the alert. Table 12 reflects on the matter of maintainability i.e. how often should the datasets be updated. Finally, to get a picture on how do these interact with each other, to achieve the final dataset for the warning, a UML depicted in figure 29 was designed.

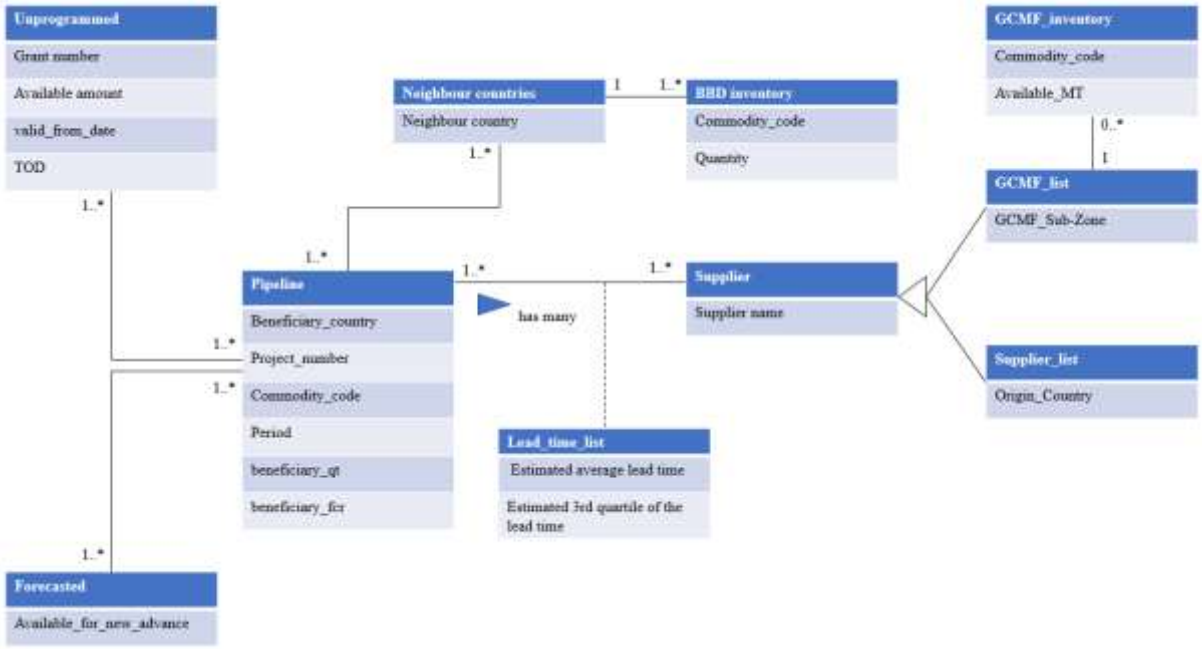


Figure 29: UML of the commodities' programming warning datasets

Note that in the flows of figure 28 there is no allusion to a Neighbour Countries nor to a BBD inventory dataset. That so happens because these are later on added in the slate module and not integrated in the final dataset for the programming of the warning. These 2 datasets report to the situation mentioned on chapter 2.1.1. With the Neighbour countries' dataset we can establish the linkage between the country with the shortage and the country with that same commodity as BBD. The BBD dataset is a file extracted from INFOHUB pertaining to the countries' commodities in-stock almost expiring.

Port congestion warning

As was mentioned during the problem development in chapter 2, to get optimal results the current project should leverage on existing projects inside the planning service. Besides data suit the current project integrated in it a project under development in the Strategic planning stream (figure 7). This project consists on the estimation of the ports congestion given upcoming POs (Purchase Orders) and PRs (Purchase Requests). To leverage on it one only had to establish a link between the country offices and the ports that they historically use in international procurement. Such was achieved through the PO report used for the estimation of the procedural lead times.

In it after identifying which lines correspond to international procurement column D_NAME (discharge port used in the shipping process) and Recipient_country (beneficiary country) were extracted. This way we know what ports are used by each country (e.g. in the case of South Sudan this uses the port of Djibouti, Mombasa in Kenya and Dar-es-salaam in Tanzania) and in the case there is more than one, when one of the ports gets congested the others can always be seen as alternatives, hence the purpose of the warning.

5.3 Implementation

In the following image it is displayed the path undertook to arrive to the final dataset *"main_lead_alert"* (which corresponds to the final dataset to be used in the commodities programming warning) through SQL transformations of the Raw datasets feed into the model as can be seen in figure 30:

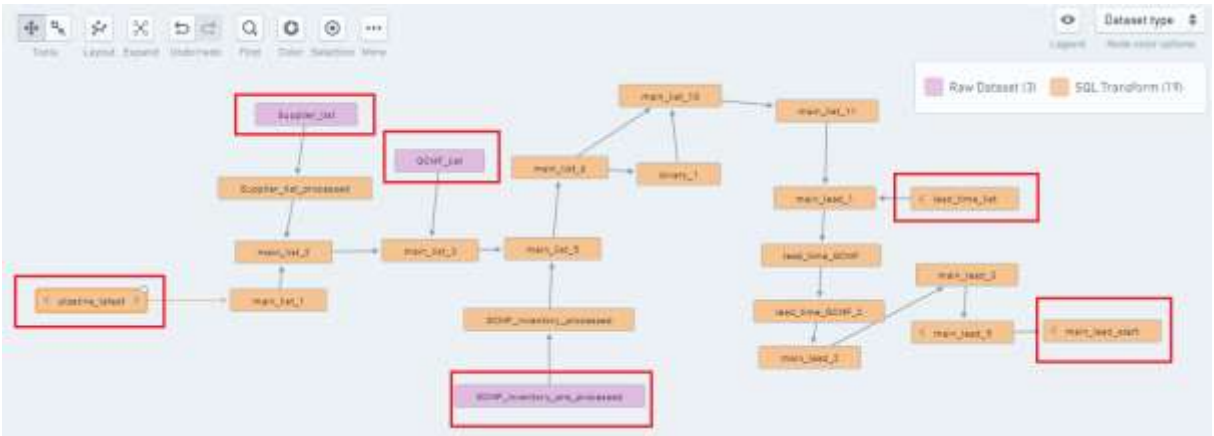


Figure 30: SQL transformations employed for the commodities programming alert

The process starts with the pipeline file (already linked to the organization's database through the common API) in which the shortfalls for a certain Country Office for a certain project and period (date when commodities are needed by the beneficiary country) occur.

The Shortfalls of a certain project are factored in 1 or 2 breaking levels that reflect the specific group of beneficiaries targeted by the project (e.g. Project 201024 has General food distribution which is then subdivided in distribution to Country "abc" refugees as well as undocumented returnees).

For the purpose of simplification, the breaking levels were aggregated by project number, commodity type and period (transformation "main_list_1").

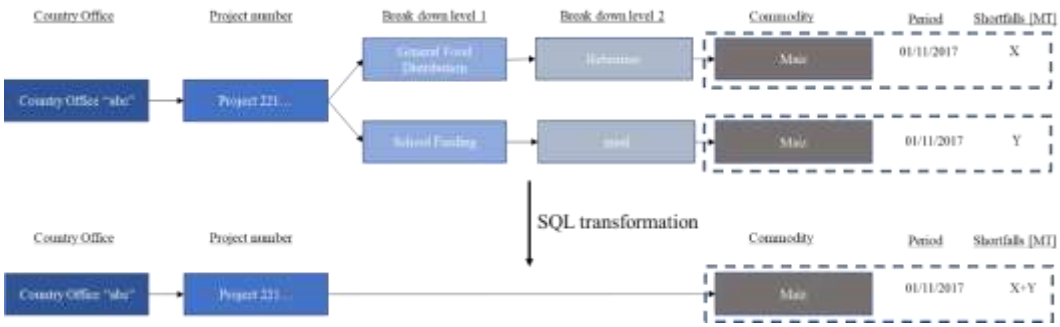


Figure 31:Aggregation of breaking levels by project, commodity and period

To the resulting transformed dataset we add the possible suppliers, which are the countries where food has been historically purchased from (transformation "main_list 2"), and the GCMF sub-zones identified for that country (transformation "main_list 3").

The assumptions made to arrive to the list of possible suppliers and GCMF sub-zones can be found discriminated in Attachment G

Knowing the possible suppliers, one needs to know what is in-stock in the GCMF facilities for the sub-zone where the country finds itself (transformation "main_list 5").

Considering the available in-stock quantity available in the respective GCMF sub-zone, whatever amount of a certain commodity the forward facility cannot fulfil has to be complemented through normal procurement (transformation “main_list 6” to “main_list 11”).

At this point of the implementation the resulting dataset from this chain of SQL transformations was tested to know if it was retrieving the proper information, and to check for possible errors in coding (the test can be seen in Attachment H).

The resulting dataset “main_list 11” is further complemented by the lead times dataset, which was achieved through a set of SQL transformations from the files available for the data suit project (see Figure 32, for further explanation see Attachment I)

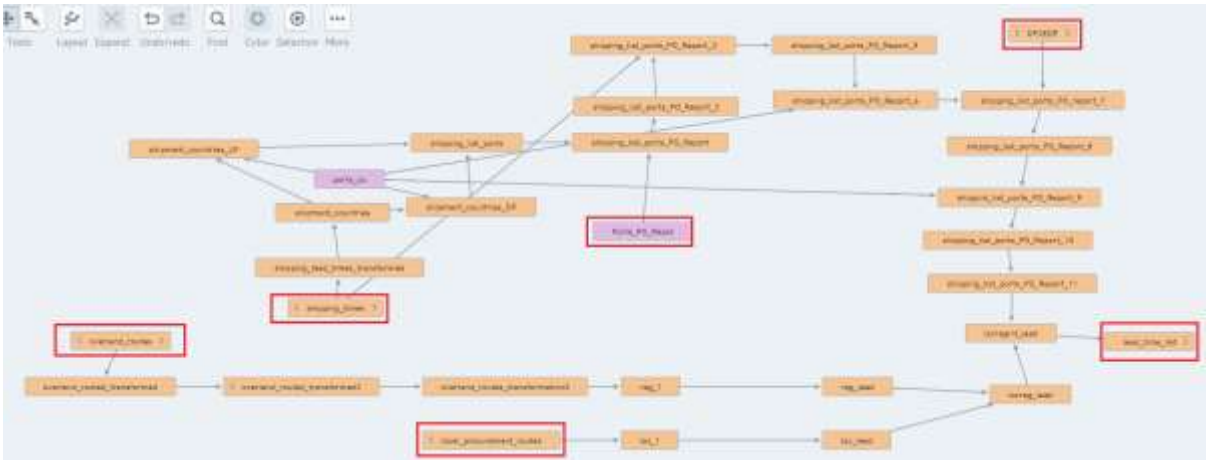


Figure 32: SQL transformations required to achieve the final lead time list

To consummate the dataset one has to integrate the specific fields required for the functioning of the alert. That is, the day after which a certain shortfall is captured by the system and the critical window to programme the commodity (circumscribed to the third quartile and the average estimated lead time for the commodities to reach the first entry point of the country).

To illustrate the concept of the fields required for the functioning of the alert, one can look at Figure 33.

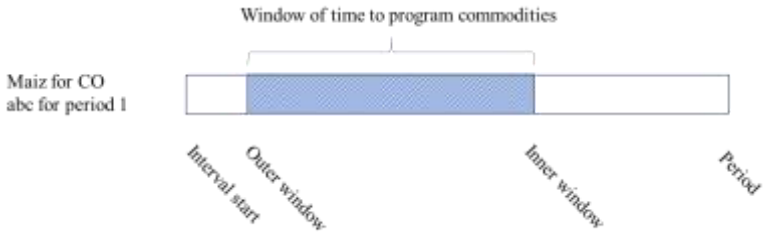


Figure 33: Critical window of time to programme the commodities

Once the interval start date is reached the shortfall is captured by the system leaving it once the period date is reached (if it is not programmed by then), as suggested by Figure 34.

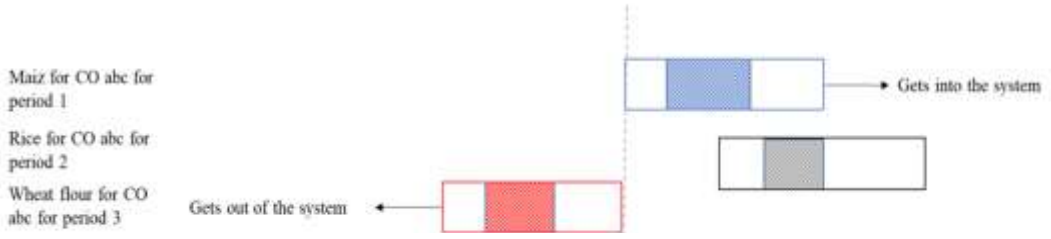


Figure 34: Functioning of the commodities programming warning

5.4 Verification and results

For the proof of concept Democratic Republic of Congo was chosen given that UN has recently declared the situation on the country as an L3 emergency[26] .

Commodities' programming warning

A snapshot of the pipeline was taken filtering for this country, for shortfalls occurring on February 2018 and for the commodities Split pleas and Maize meal portrayed on these same shortfalls.

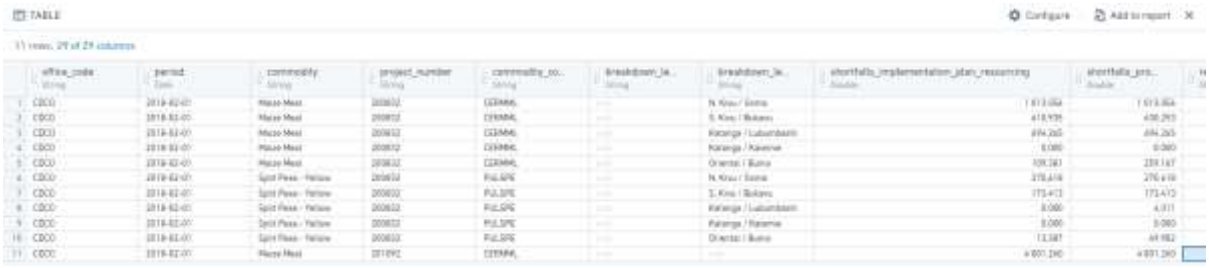


Figure 35: Pipeline Snapshot for Democratic Republic of Congo taken from foundry

The pipeline on Figure 35 shows that there is a shortfall of Maize Meal for project 200832 in the total amount of 2427.637 MT of food and in the amount of 4801.260 MT for project 201092. It also shows a shortfall of 457.418 MT of Split Peas in project 200832.

The final warning system (see Attachment J for a clearer picture) is displayed below for the case of Democratic Republic of Congo for the selected period (February 2018).

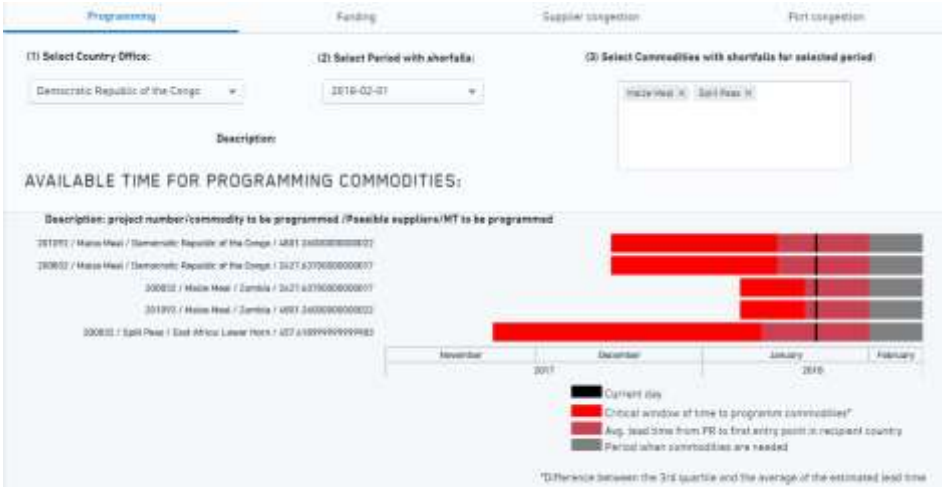


Figure 36: Commodities programming warning

The warning system for the commodities programming shows that there are 2427.637 MT and 4801,260 MT of Maize lacking for February for project 200832 and 201092 respectively. This amount can be resourced in the own country (local procurement) or in Zambia (regional procurement) which is bordered by DRC. There is also the need to programme 457.418 Split Peas which are available in GCMF East Africa: Lower Horn. For all the suppliers the limit time to programme these commodities (defined as the period when these are needed minus the average time to get them on the first entry point of the beneficiary country) was already surpassed, according with the estimated lead times from the data suit datasets.

[26] http://www.irinnews.org/in-depth/crumbling-congo-making-humanitarian-emergency

The programming warning also shows that there are USD 8.58k left to use from unprogrammed resources and AF released and still not earmarked in the amount of USD 4.85 Million for project 200832 and 201092 respectively. On the right side of Figure 37 one can also see if there is any GCMF facility with stock available for the shortfalls portrayed on Figure 36[27].

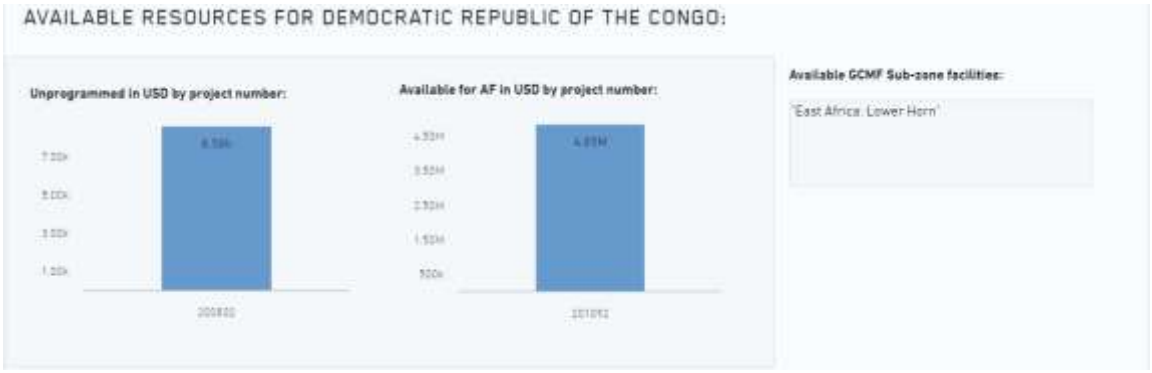


Figure 37: Available resources for programming the commodities

Finally, the programming warning also displays what commodities are expiring within 3 months, in neighbour countries of DRC, that are not contemplated for distribution in those same countries during that period.

Figure 38 shows that there are 54.85 MT of Maize expiring on February 31st in Zambia. The objective of incorporating such information in the programming warning can be found on chapter 2.1.1.

Figure 38: Commodities almost reaching the BBD

[27] As is inferred by table 12 the information pertaining to the unprogrammed resources has been manually updated for what the information displayed in Figure 37 may be no longer up to date.

Funding warning

Regarding the unprogrammed resources available for DRC depicted in Figure 37 the funding warning captures if there is any donation (grant) pertaining to those same projects that may be almost expiring given their TOD.

Figure 39: Funds Unprogrammed Report Snapshot taken from Foundry

[28]Figure 39, a snapshot of the unprogrammed report, shows that there are 2 grants, though with a very small amount, both expiring on the 30th of April 2018, as is depicted on the warning in Figure 40.

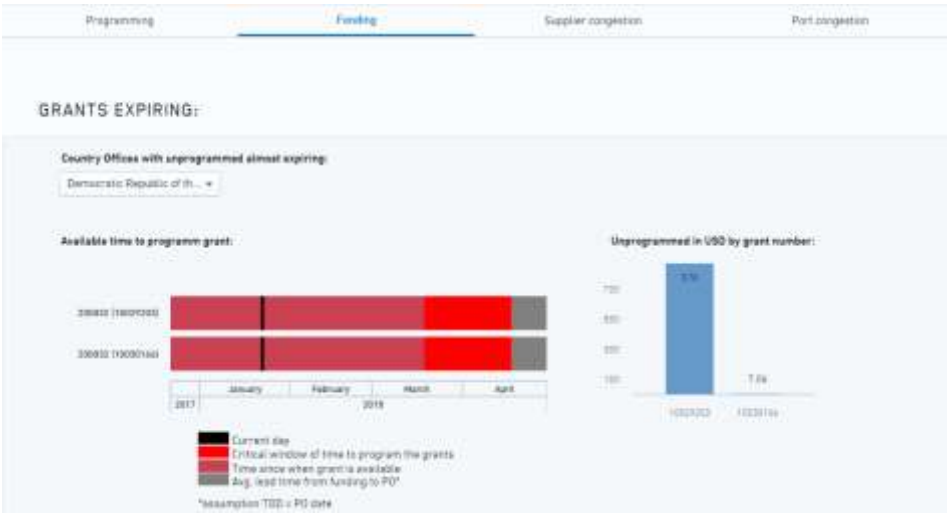


Figure 40:Funding warning

Port Congestion

Regarding the Ports that DRC has historically used we can see through figure 41 that, in what concerns International procurement (that may require shipping between ports), there are no problems in terms of congestion, at least in the foreseeable future.

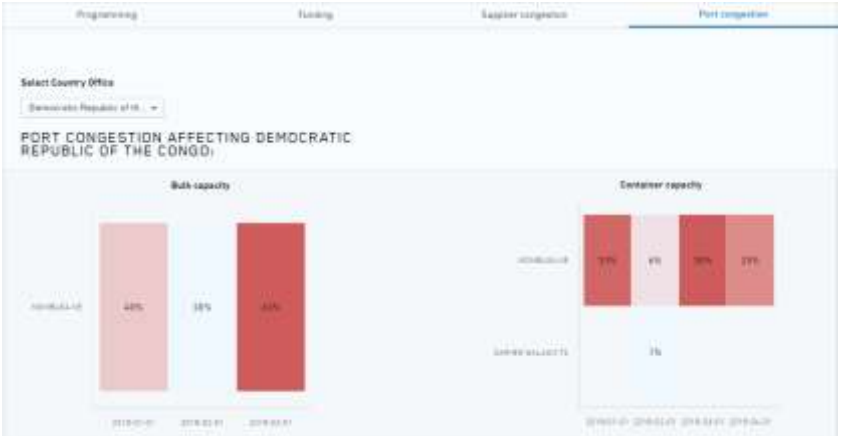


Figura 41: Port Congestion warning

[28] Cargo can be brought by Vessel in Bulk or the cargo may be containerized (CNT) which will depend on the type of commodity. Different type of shipments (Bulk or CNT) will require different resources from the port, which will then reflect different capacities for the 2 types

5.5 Limitations

The limitations concern the assumptions made to conceptualize the alarm, without which it wouldn't be possible to advance in the same:

The list of the suppliers was gathered from the PO report. In the report since there was no clear consensus about how to get to the direct supplier of WFP (there are 2 columns in the PO Report "Origin Country" and "Vender Country") and to minimize the possibility of error it was considered for supplier only the Countries whose "Origin Country" in PO Report matched the "Vendor country". This way we could be overlooking important suppliers.

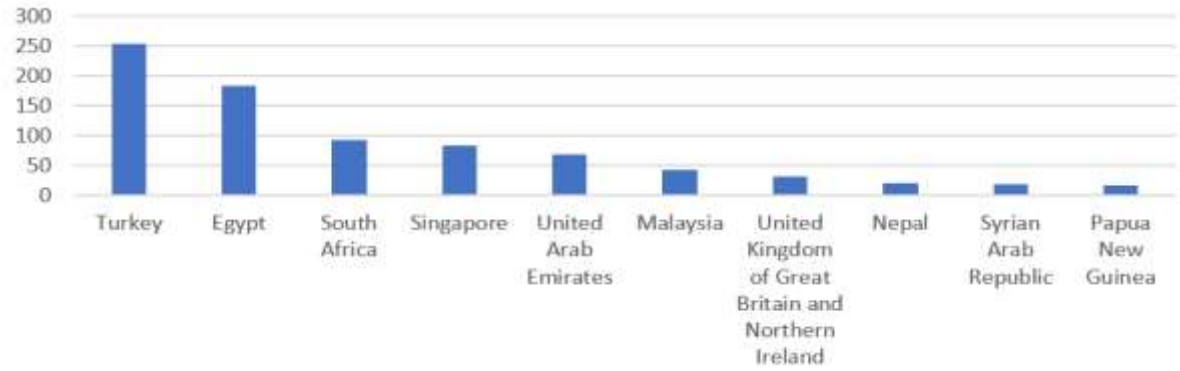


Figure 42: number of PO line items by Vendor Country for the case where the Vendor didn't match the Origin Country (PO report of 2014-2017)

To get to the lead times all dispatch ports from USA (US) were discarded since usually most of the cargo coming from this country correspond to IN-KIND.

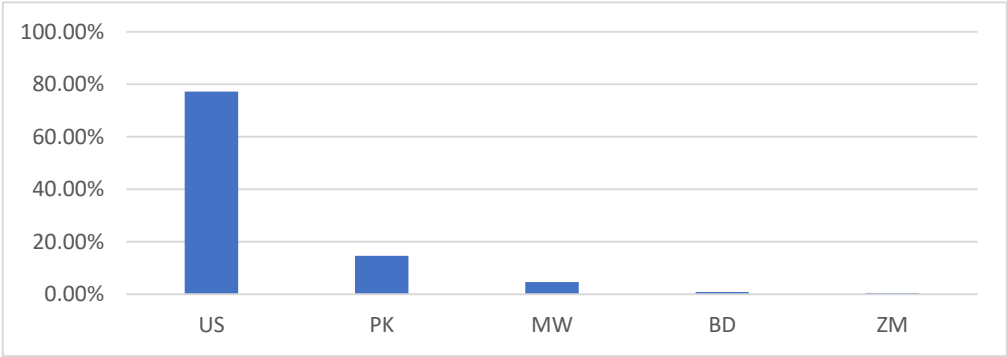


Figure 43: Top 5 countries for IN-KIND in % of total traded commodities (PO Report of 2014-2017)

When displaying the resources available it is not contemplated if the grant corresponding to that resource has restrictions associated with it that may make it invalid (see chapter 2.1.2).

It was not contemplated as a possible supplier the UNHRD (United Nations Humanitarian Response Depot).

The programming warning is too reliable on the accuracy of the lead times extracted from datasets used in the Data Suit project.

It was also mentioned that since in the pipeline there is no delivery point defined, the first entry point in a country was considered the final point of the supply chain lead time. Notwithstanding given the fact that the first entry point captured in the CTR (the basis for the data suit project lead times) is very diverse (sometimes it is a WH in a location A other times it is a WH in location B), such variety helps offsetting the problem since different entry points will be located in different zones of the country giving origin to different lead times.

There should also not be discarded negative externalities that may arise from the implementation of such system. Even though it may help some COs to take action more promptly (in case the concept proves to be successful) it may also lead proactive COs to accommodate to the system and restrain themselves from looking to more viable solution in the meantime (before the warning gets released).

Again it should be stressed that Supply Chain visibility initiatives shouldn't be seen as prescriptive rather as a tool for decision support allowing organizations to act more promptly on timely and accurate information. (Stanchik 2016)

6 Conclusions and Future work

During the internship at WFP a collection of putative problems affecting the supply chain were collected.
For the problems selected to be depicted in the warning system, 2 were already noticed during the Global Supply Chain meetings (supplier and port congestion). The remaining ones (not programming the commodities when there were resources to do so and grants expiring) were elucidated through the data analysis done. To understand how should the system be designed, the Supply Chain areas with which the warning system interacts were clarified through the design of the process flows involved.

A technological solution to deploy the system was proposed and in the same created from the ground up.

The solution was also tested with positive results.

Critical next steps to be accomplished next are:

- Supplier congestion warning (still not done due to time restrictions)
- Assembling the email warning functionality (for now a CO officer can only visualize when a situation is critical)
- Programming of the tabs of the warning platform to become red whenever a country office with shortfalls accesses Palantir.

For the assembly of the email warning functionality one ought to resort to SQL triggers[29].

These procedures, triggered every time a single row of the dataset used to elaborate the platform achieves the threshold defined in table 11, would then initiate the action of sending an email to a designated email address. Depending on the warning type (programming, funding…) we would then have different email addresses pertaining to the subject targeted by this same warning.

After the completion of these 2 tasks one country should be used to deploy the model.

Also, during the internship in the Supply Chain Planning service it was noticed that, given the planning service touching all the functions of WFP's Supply Chain, the myriad of concepts and processes one has to be acquainted with, which sometimes are not well defined nor standardized (many dispersed over many information platforms) it is proposed the creation of a "*Supply Chain Planning starter's pack"* manual.

This manual would be used as an integration tool for someone entering the planning service and would entail:

- Description of processes from funding to beneficiaries
- Description of tools that are being used (PR Report, PO report, Pipeline) and the specificities of this same tools (e.g. The PO report has many column names, some of which are not straight forward).
- Description of the systems used (Quinteq, Optimus, Palantir's Foundry) as well as an introduction to the same with examples of usage.

This would enable the new entrant to have a holistic view of the organization and at the same time speeding up her/his process of integration and familiarization with the work being done. The present thesis could be used for a first sketch of the processes used in such manual, given that it touched many areas of the Supply chain.

[29] SQL trigger is a special kind of stored procedure that automatically executes when an event occurs in the database (e.g. when a certain capacity or a certain date is reached)

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Attachment A: Regional Bureaus

Figure 44: Regional Bureaus taken from
http://documents.wfp.org/stellent/groups/public/documents/communications/wfp253669.pdf

Attachment B: Organigram

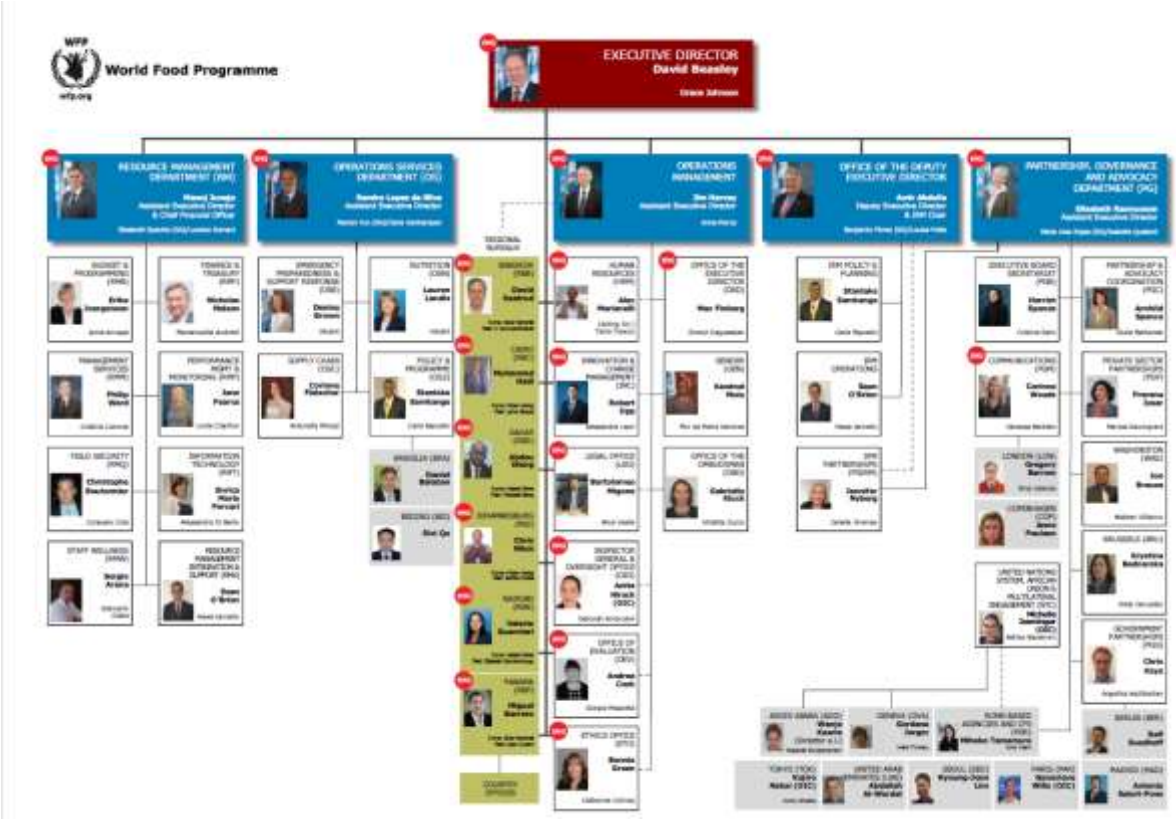


Figure 45:Organigram of the company

Attachment C: Problems collected

Table 14: Problems collected

Global SC planning	Organizational process flow	Dashboards	Interviews	KPI	Budget programming manual 1
Source congestion Load on corridors Load on warehouses BBD Limited production capacity for SNFs	There is no mechanism to warn if a CO submits a certain pipeline with a demand for the next months higher x% than the previous months tender takes more time than what was expected There is no mechanism in place to tell whether or not a certain request is feasible in terms of lead-time There is no communication on-time with the shipping department to know whether or not a shipment is within the stipulated dates	low funding forecast at the moment doesn't allow the activation of AF mechanisms upcoming months shortfalls Operational shortfalls due to logistics or security constrains significant shortfalls in food pipeline due to increased requirements for exercise Government bans on certain commodities Commodities expiring with no option to move them due to the security situation WH are un-accessible due to the security situation critical nutrition commodities are expected to run out starting Nov'17	orders that are late potential congestion at ports orders received with infeasible delivery lead times poor performance on downstream node changes on the demand not dully communicated Stocks not correct (too much of one commodity too few of another) Funding needs not dully communicated There is no communication on time with the suppliers to know whether or not they comply with what was on the contract Vessel don't dispatch on time Commodities don't arrive on time at the port of dispatchment Lack of clear metrics as for when should a supplier have the commodities ready Lack of funding Funding restrictions There is lack of visibility and procedures to deal with IN-KIND donations	Assistance ordered delivered in the recipient CO on time (RTA) % change in number of transactions captured in real-time in LESS Order to delivery to CO cycle time time in LESS Number of Days between STO planned dispatch date and actual Lead time for Delivery to CP $ and MT change in food losses due to expired best before date	requirements/shortfalls have significantly changed from precious months (Are they explained and supported by the budget?) Closing stocks not equal to opening stocks of reporting month Incorrect reporting of real needs to the donor community Inaccurate procurement and logistics operations execution which may cause pipeline break (any sudden changes if projected to be significant and lasting should be reflected in the pipeline project plan as soon as they are identified) Requirements and shortfalls over the next 13 months period underestimated Replenishment of GCMF stocks lower than the actual future demand

Budget programming manual2	Budget programming manual 3	LESS (COMPASS)	WINGS	LESS (COMPASS)	COMMET
Reporting to donors for fundraising underestimate the future funding requirements The data used is not the most up to date, therefore Procurement and Logistics may not have enough resources to fulfil the requirements or have too many resources not in the right place Associated cost rates inaccurate (increases the risk of associated cost shortfalls or surpluses when implementation levels change) actual contributions are often less than the needs-based project budget – creating a disconnect between an approved project plan and resources available to implement it COs are not required to submit a formal implementation plan aligned with the resource outlook for the project.	CO undertakes implementation planning as per their own practices, the lack of corporate policy and related tools results in no standardization nor corporate visibility of such plans planning horizon for implementation plan is only 3 months GCMF may purchase too much or too little, or not the correct commodity and the working capital will be locked in stock that cannot be consumed When calculating Net Funding Requirements (pipeline shortfalls - unprogrammed funds + outstanding advances), available resources will be overstated	The data used is not the most up to date, therefore Procurement and Logistics may not have enough resources to fulfil the requirements or have too many resources not in the right place. Lack of data reliability Lack of standard procedures to insure that the required information such as GR.doc.date RTA are correct and up to date Lack of communication with the Shipping department which doesn't allow for a correct assessment of the position of the commodities on the supply chain and to react on time to certain events such as a delay There is no definition for the time elapsed from the moment the supplier receiver the PO until the moment the commodity is delivered at the port There is no standardization of procedural lead times	There is no mechanism in place to automatically detect when an order for which a PO date has been already created didn't passed through a certain check point on time System should be easier to manipulate to avoid lack of commitment by the staff registering the dates and enabling reliable real time visibility The system which contains the check point dates to monitor the commodities is too reliable on the staff (an automatic check point system should be in place)	There is nothing linking the pipeline to the PR report Country offices overestimate their requirements Lack of understanding of the terms used in the PO Report Big gap between ETS and ATS No link between pipeline and PO report	Double counting beneficiaries due to overlaps in time or overlaps in space

Attachment D:

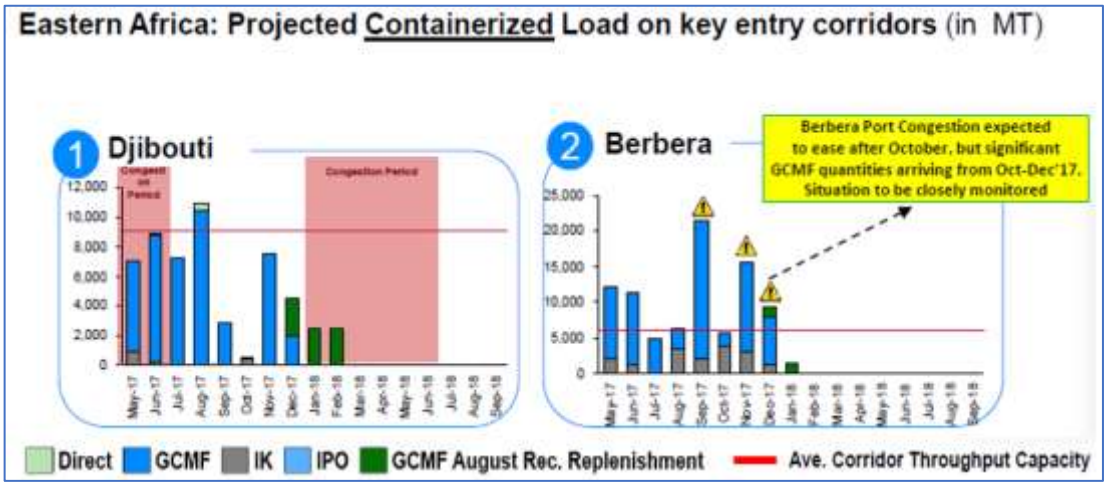


Figure 46: Global Supply chain overview September 2017

Figure 46 displays the projected load on Djibouti and Berbera port. In both the red line, which symbolizes the throughput rate of the port, was already surpassed on August and May 2017 respectively.

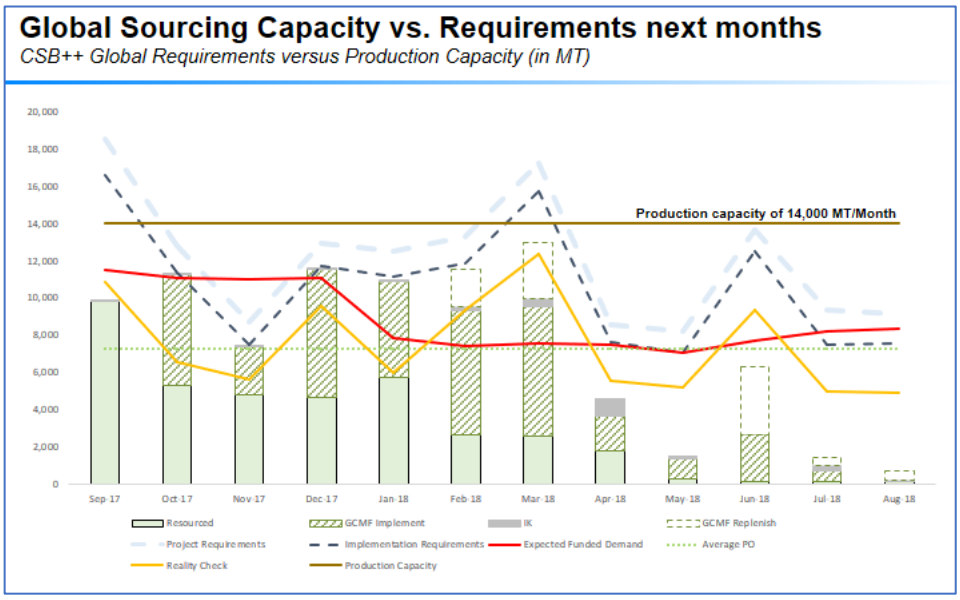


Figure 47: Global Supply chain overview August 2017

Figure 47 which depicts the monthly production capacity of CSB++ and the respective implementation requirements clearly shows that the requirements for March 2018 already surpass the supplier's capacity for the same month.

Attachment E: Lead times

From a PO report spanning across almost 2 years (from January 2016 to October 2017) and after it being cleaned for outliers and odd data the lead times ought to be statistically inferred. Before commencing with such exercise, one must have in consideration the several incoterms[30] dealt by WFP's supply chain. These incoterms concern:

Rules for any mode or modes of transport:

- EXW (ex works)
- FCA (free carrier)
- DAT (delivered at terminal)
- DAP (delivered at place)

Rules for sea and inland waterway transportation:

- FAS (free alongside ship)
- FOB (free on board)

The interactions between the supply chain milestones and the type of contract in place are elucidated in the following table for the case of international procurement

Incoterms	Load to Truck	Export-Duty Payment	Transport to Exporter's Port	Unload from Truck at Port of Origin	Transport to Importer's Port	Landing Charges at Importer's Port	Unload onto trucks from the Importer's Port	Transport to Destination	Insurance	Entry-Customs Clearance	Entry Duties and Taxes
DAP	Supplier	Supplier	Supplier	Supplier	Supplier	Supplier	Supplier	Supplier	WFP	WFP	WFP
CFR	Supplier	Supplier	Supplier	Supplier	Supplier	Supplier	WFP	WFP	WFP	WFP	WFP
FOB/FAS	Supplier	Supplier	Supplier	Supplier	Supplier	WFP	WFP	WFP	WFP	WFP	WFP
FCA	Supplier	Supplier	Supplier	WFP	WFP	WFP	WFP	WFP	WFP	WFP	WFP
EXW	WFP	In this incoterm there is no shipping. Only landside transportation						WFP	WFP	WFP	WFP

Figure 48: Incoterms used

[30] "Incoterms is a series of pre-defined rules relating to particular terms used in international commercial transactions to ensure that both parties understand their rights and obligations. The primary intention of Incoterms is to clarify 'who does what' and 'what each pays for' in terms of the transportation, insurance and delivery of goods" (https://www.scm-portal.net/glossary/incoterms.shtml)

Local Procurement

For the analysis of the lead time in the case of local procurement we are going to take only in consideration the PO lines whose incoterm is DAP.

Table 15: Incoterms used in LOC

Incoterm	% usage
CFR	0%
CIP	0%
DAP	75%
EXW	6%
FCA	20%
FOB	0%

The reason for the choice is twofold. First because it comprehends the time elapsed from the supplier until the beneficiaries, which greatly simplifies the analysis. Second because for the clean PO report it represents 74% of the incoterms for Local procurement.

In the PO report for this object of analysis there are 2 key dates:

- PO date: date when supplier receives the order
- "GR DOC. DATE": which is the date when the commodities were received by WFP from the supplier (which for the DAP are the beneficiaries

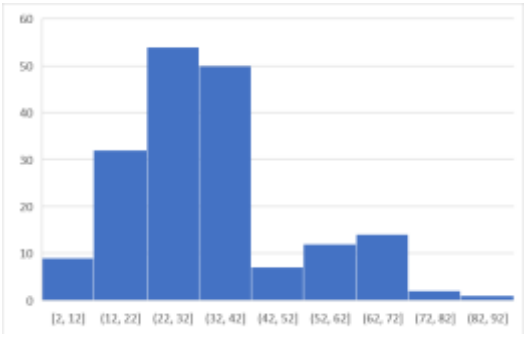


Figure 49: Egypt LOC lead times histogram

Table 16: Statistics on Egypt LOC lead times

	Egypt	
N	181	
average	34.56906077	days
var.	265.9243708	days2
st.desv.	16.3071877	days
min	2	days
Q1	24	days
median	32	days
Q3	40	days
max	83	days
start date	26/02/2016	
end date	15/08/2017	

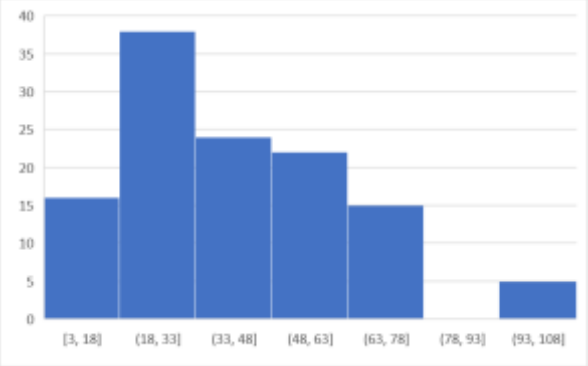


Figure 50: Iraq LOC lead times histogram

Table 17: Statistics on Iraq LOC lead times

	Iraq	
N	120	
average	41.016667	days
var.	444.40308	days2
st.desv.	21.08087	days
min	3	days
Q1	24	days
median	42	days
Q3	54	days
max	95	days
start date	29/06/2016	
end date	08/06/2017	

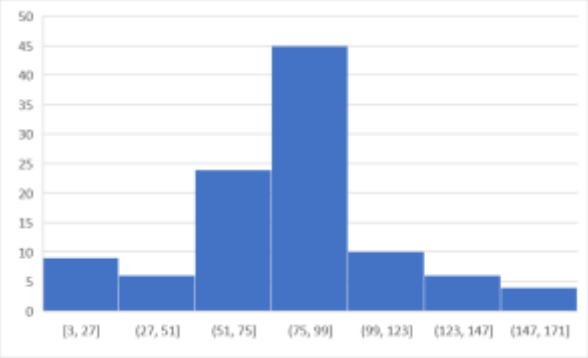


Figure 51: Syria LOC lead times

Table 18: Statistics on Syria LOC lead times

	Syria	
N	104	
average	81.375	days
var.	1072.5667	days2
st.desv.	32.750065	days
min	3	days
Q1	57	days
median	82	days
Q3	95.5	days
max	169	days
start date	22/01/2016	
end date	27/08/2017	

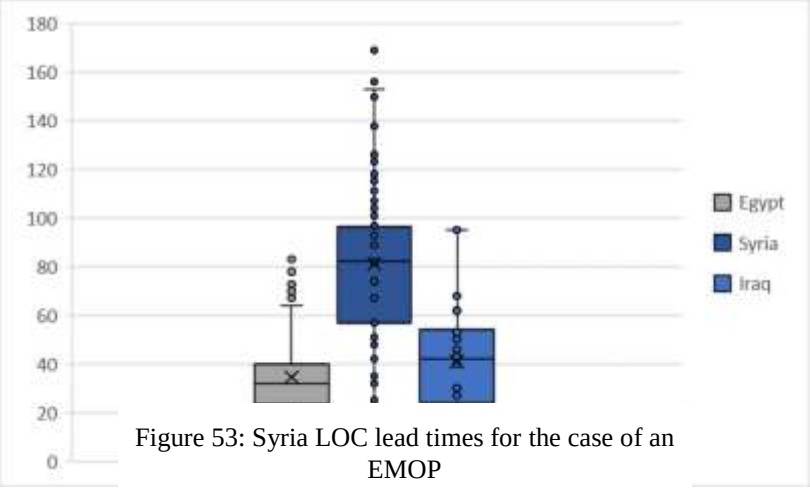


Figure 53: Syria LOC lead times for the case of an EMOP

Figure 52:LOC lead times boxplot

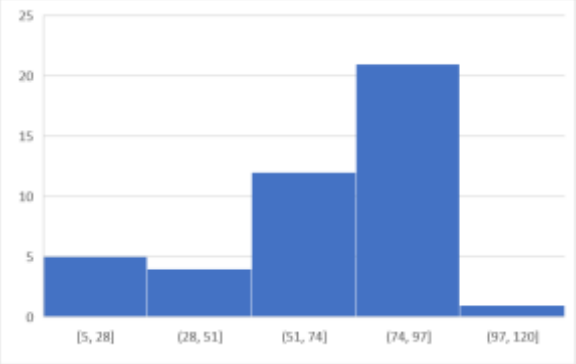


Figure 54: Syria LOC lead times for the case of a PRRO

Table 19: Syria's EMOP lead time statistics for LOC

Syria (PRRO)		
N	43	
average	65.6512	days
var.	528.614	days2
st.desv.	22.9916	days
min	5	days
Q1	57	days
median	82	days
Q3	82	days
max	109	days

Table 20: Syria's PRRO lead time statistics for LOC

Syria (EMOP)		
N	61	
average	92.459	days
var.	1169.12	days2
st.desv.	34.1924	days
min	3	days
Q1	74	days
median	93	days
Q3	107	days
max	169	days

Besides the variation observed between different countries, in what concerns the lead times from supplier to destination point, being markedly different has is patent in Figure XXX for Syria and Egypt, there is also the variation factors in each country that ought to be considered. Such factors, has the type of operation in place, can greatly influence the lead times.

Usually a humanitarian Supply chain oscillates between a push and a pull system.

When an EMOP is triggered in the onset of a disaster, needs usually are not clearly defined, logisticians have little notice on how much material they must move and the office coordinating the aid mission is far away from the actual disaster. In such conditions and not knowing exactly to where and through where should the cargo go the pull system strategy is commonly employed. Rodman (2004)

Once the response teams arrive to the scene and get the picture of the situation the supply chain can transition from a push to a pull system. It is natural then to have different lead times in different time stances along the course of the operations. Other factor that might impact the lead times is the type of commodity concerned, given the fact that different family products are handled differently, with different types of packaging and the way they are carried (some are containerized others are shipped in bulk). Some may have short shelf lifes others may be easily stocked being already available in an easy to reach sight before the onset of the disaster. All of these factors presuppose a lot of variability on the lead times to be integrated on the warning system.
For the reasons above stated, the time available for the project and the fact that it wouldn't be practical to make an in-depth analysis of the lead times for all countries in which WFP operates, the project changed from a statistical approach to a more pragmatic one. Based on the lead times scattered across the many reports already available for the data suit project, this ought to be collected and linked through a set of SQL transformations.

Attachment F: Procedural lead times estimation

From the processes described in chapter 3 for procurement it wouldn't be unreasonable to assume that the different types of tender would have some impact in the lead time from a PR to a PO.

There are 2 possibilities of tender, through a competitive bidding process or through a Direct tendering or waiver of competition, which will be henceforward referred to as POFC and POFW respectively (names as per the PO report).

At the same time, it could be possible that the type of procurement may impact this lead time, since different organizational structures may undertake the procurement process.

According to "*WFP Food and Procurement Manual"*:
"*International procurement can be undertaken by HQ, or by the CO/RB…*"
"*Generally, local/regional procurements are undertaken by the CO/RB …*"

Hence the factors to be analysed can be summarized as follows:

Table 21: Factors involved in PR to PO lead times

Possible factor	Scale
Type of tender	Nominal
Procurement type	Nominal

For the analysis of the type of tender a random sample of 300 observations was drawn from a clean dataset (created after linking the PO report to the PR report through the PR line item serial number) using the rand() function in excel for the 2 groups (POFW and POFC) to ensure randomness.

Table 22: Description of the values found in POFC and POFW samples

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
POFC sample	300	12.497	0.647	11.203	1.000	2.000	10.000	19.750	48.000
POFW sample	300	11.927	0.648	11.215	1.000	3.000	7.000	19.000	48.000

Afterwards the normality of the distribution for the two samples was tested with a normal probability plot.

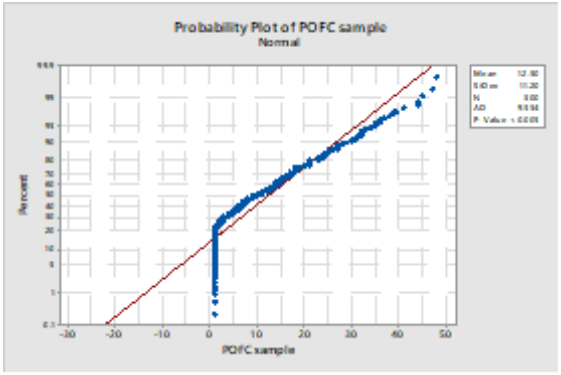


Figure 55: Probability Plot of lead times for POFC

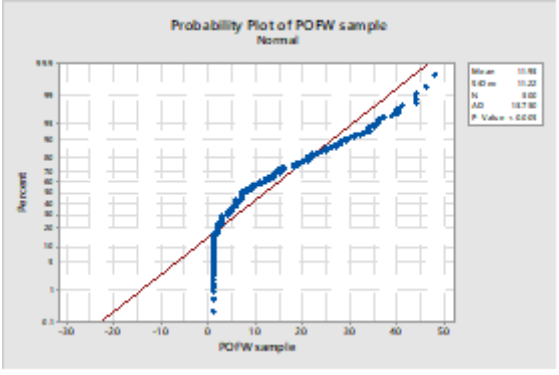


Figure 56: Probability Plot of lead times for POFW

Departures from the straight line indicate departures from normality.

The points on the plot for both samples don't form a nearly linear pattern, which indicates that the normal distribution is not a good model for this data set.

Since normality was not observed we have to resort to a non-parametric test that doesn't require this assumption.

For that matter the test preferred in this situation is the test of Mann-Whitney-Wilcoxon.

For the purpose of the test, in both groups, it should be observed equally shaped distributions. For that one can resort to descriptive statistics

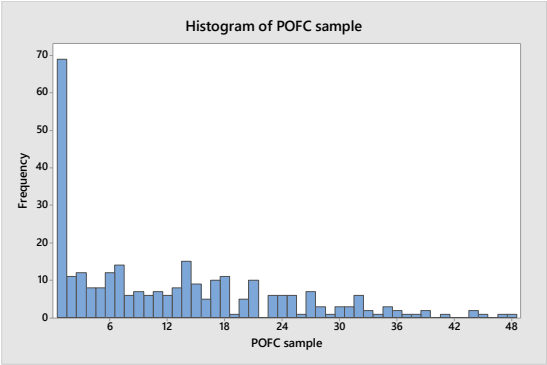


Figure 57: Histogram with lead times' frequency for the case of POFC

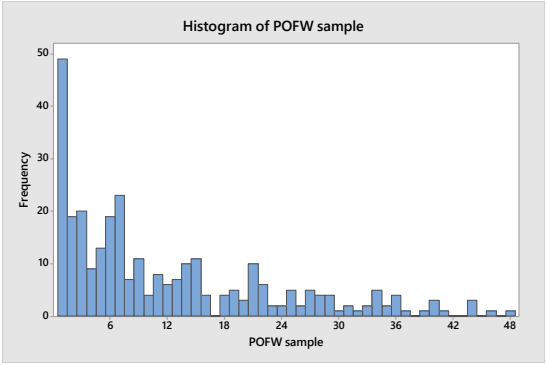


Figure 58: Histogram with lead times' frequency for the case of POFW

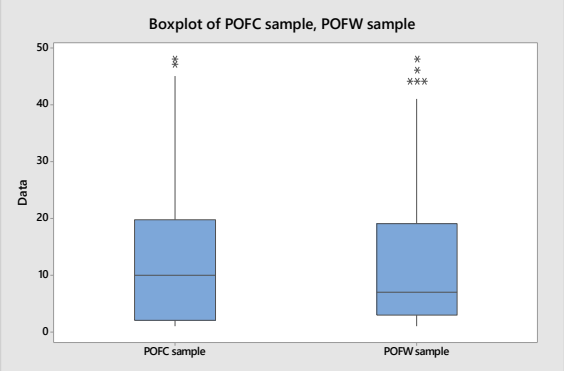


Figure 59: Boxplot of the lead for POFC and POFW

As shown in the histograms the shape outline for both samples seem similar as well as the distance between the top whiskers and the upper quartile in the boxplot diagram. It is not unreasonable thus to assume equally shaped distributions for both groups.

Method:

η_1: median of POFC sample

η_2: median of POFW sample

Difference: $\eta_1 - \eta_2$

Test results:

Null hypothesis	$H_0: \eta_1 - \eta_2 = 0$
Alternative hypothesis	$H_1: \eta_1 - \eta_2 \neq 0$

Method	W-Value	P-Value
Not adjusted for ties	90950.00	0.706
Adjusted for ties	90950.00	0.705

Interpretation:

At a level of significance of 5% there is no statistical significance that allows us to exclude the possibility that the median of both groups don't differ, which is further attested by a p-value of more than 70%, hence the test is inconclusive. This may be justified by a lack of standardized procedures with clear defined deadlines which is noticeable when one looks at the standard deviation.

Giving this test to be inconclusive the next step was centred in the type of procurement.

For this only the POFC was considered. The reason is twofold:

1. This is the predominant type of procurement, representing the majority of cases.
2. By only taking one type of tender in consideration one can eliminate the interaction factor between the type of procurement and competition.

Table 23: Data statistics as per the type of procurement

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
INT	783	13.524	0.369	10.336	1.000	6.000	11.000	18.000	48.000
LOC	1465	12.928	0.326	12.465	1.000	2.000	8.000	22.000	48.000

Given the dispersion of the data in table 8 the study was adjusted to reflect the effect of the country in the procurement lead times.
Again, data is scattered in such a way that any statistical conclusion should be seen with some prudence.

The same procedure as the one suggested for the type of tender was developed for each country. Notwithstanding as is easily demonstrated with Syria given the fact of the distributions pertaining to the 2 samples in each country to have non-equal shape the Mann-Whitney-Wilcoxon test could not be applied and hence no conclusions could be made.

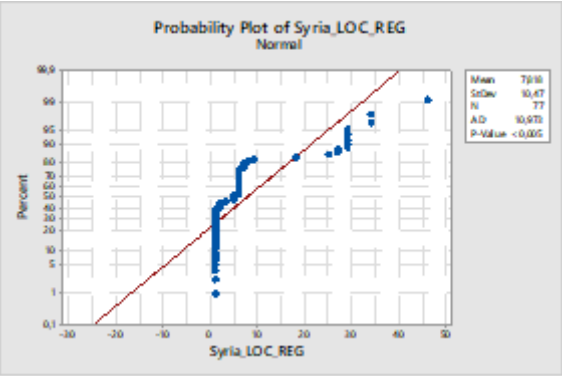


Figure 60: Probability Plot of Syria's lead times for LOC

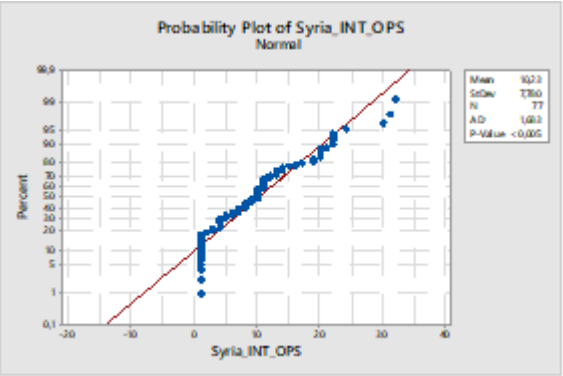


Figure 61: Probability Plot of Syria's lead times for INT

As it is easily observed the samples don't follow a normal distribution

Table 24: Data statistics as per the type of procurement considering the country

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Syria (LOC)	77	7.82	1.19	10.47	1.00	1.00	5.00	6.50	46.00
Syria (INT)	262	11.408	0.605	9.799	1.000	4.000	10.000	15.000	42.000
Iraq (LOC)	120	2.217	0.258	2.826	1.000	1.000	1.000	2.000	13.000
Iraq (INT)	36	9.92	1.68	10.10	1.00	2.25	7.50	12.00	45.00
Myanmar (LOC)	118	9.805	0.941	10.227	1.000	3.000	4.000	17.000	44.000
Myanmar (INT)	37	15.76	2.01	12.23	1.00	9.00	12.00	19.00	48.00

Neither do the samples have equal shape distributions.

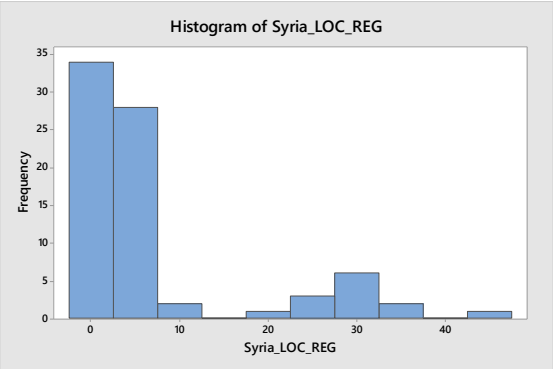


Figure 62: Histogram with lead times' frequency for the case of LOC in Syria

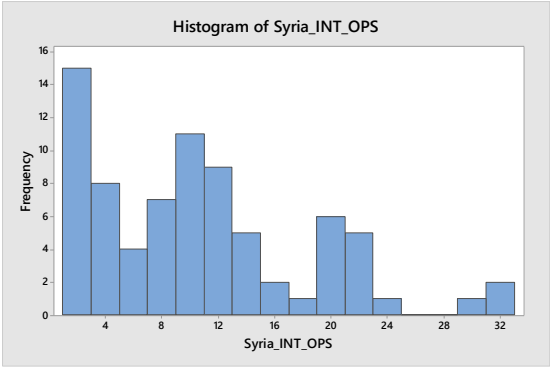


Figure 63: Histogram with lead times' frequency for the case of INT in Syria

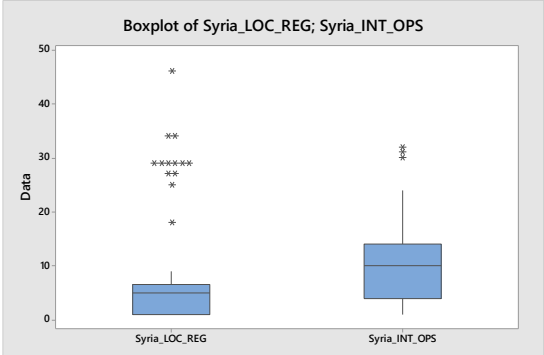


Figure 64: Boxplot of the lead times for the case of LOC and INT for Syria

Attachment G: Assumptions made

Assumptions made to know which countries are under the scope of each GCMF sub-zone

For GCMF the countries served by each facility are discriminated in the GCMF manual as follows:

GCMF PLANNING ZONE	SUB-ZONE	STATUS	SERVED COUNTRIES
Middle East		Active	Syria, countries under the Syria Regional operation
East Africa	Lower Horn	Active	Burundi, DRC*, Kenya, Rwanda, Somalia*, South Sudan*, Tanzania*, Uganda
	Upper Horn	Active	Djibouti, Ethiopia, Somalia*, South Sudan*, Sudan, Yemen (when served from Djibouti)
West Africa	Western Sahel	Active	Benin, Burkina Faso, Mali, Niger
	West Africa Coastal and Eastern Sahel	Active	Cameroon, CAR, Chad , Guinea, Liberia, Mauritania, Sierra Leone
Southern Africa		Active	DRC*, Lesotho, Madagascar, Malawi, Mozambique, Swaziland, Tanzania*, Zambia, Zimbabwe
Asia	Western Asia	Not active	Afghanistan, Iran, Pakistan
	Far East	Not active	Bangladesh, Bhutan, Cambodia, DPR Korea, Indonesia, Lao PDR, Myanmar, Nepal, Philippines, Sri Lanka
Latin America & Caribbean	Central America	Active	Cuba, El Salvador, Guatemala, Haiti, Honduras, Nicaragua
	South America	Not active	Bolivia, Colombia, Ecuador

Figure 65: GCMF Subzones “Global Commodity Management Facility INFORMATION & INTERIM GUIDANCE NOTE”

From the list in Figure 46 the COs served by GCMF may be inferred, notwithstanding one has to take into consideration that the food security scenario of the countries changes along time as do their requirements.

Since GCMF planning zones are ascertained by the strategic demand plan of GCMF, which in turn is built around country requirements, one can conclude that the countries served by GCMF also change accordingly.

Taking that into consideration the “GCMF_list” has to accommodate for that factor, needing a constant update at least yearly (which is the time span captured by GCMF strategic demand plan) of the countries covered by GCMF.

For the purpose of the model an estimation of the countries covered has to be made. One possible way to do so is to look to the overall GCMF sales report.

The Sales report is the document containing the data of all the commodities bought in advance by GCMF for which IPOs were raised.

From the countries figured on the data the distinction between countries served and not served by a certain GCM Sub-zone must be made.

The method employed to make such distinction can be elucidated in the following exercise for East Africa Lower Horn Sub-zone.

As a rule of thumb for the filtered data for the current year (2017) the COs with a number of orders that differ significantly from rest were considered outliers, hence should not be included under that same Sub-zone.

Table 25: East Africa Sub-zone

East Africa: Lower Horn	number of IPO lines
CO-BANGLADESH	7
CO-BURUNDI	48
CO-CENTRAL AFRICA REP.	7
CO-CONGO D.R.(Kinshasa)	20
CO-ETHIOPIA	3
CO-KENYA	70
CO-RWANDA	30
CO-SOMALIA	72
CO-SOUTH SUDAN	174
CO-TANZANIA	53
CO-UGANDA	170
CO-YEMEN	6
RB/CO-SUDAN (KHARTOUM)	1

It becomes clear through the analysis of table 6 that Bangladesh, Central Africa Republic, Ethiopia, Yemen and Sudan don't belong to the East Africa Lower Horn Sub-zone.

Assumptions made regarding the putative suppliers for each commodity for a given country

A way to infer the Country suppliers is by analysing the historical data present in the PO Report, since it contemplates all the orders to the suppliers

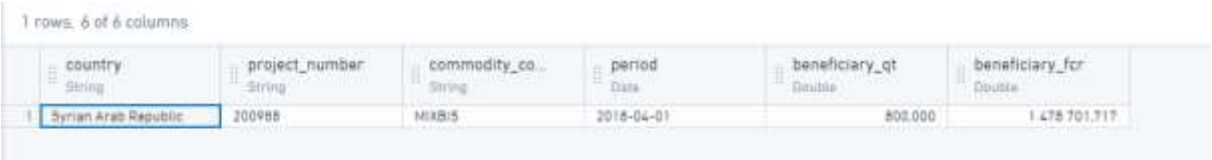
The file presents 2 columns, the Origin Country and the Vendor Country columns

Since there was no clear consensus about which of the columns represented the Supplier, from whom WFP directly purchased the commodities, only the lines of the report where the Vendor was the same as the Origin Country were considered.

A list of all Supplier Countries as well as the commodities by these supplied was collected from a PO report with data ranging from January 2016 to October 2017.

Attachment H: Testing code correctness

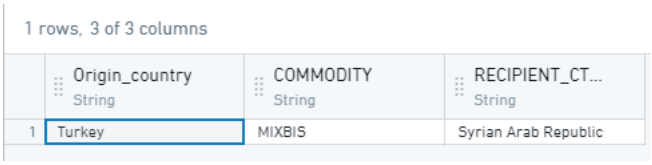
A test line was added to main_list_1, that captures the shortfalls on the pipeline.



1 rows, 6 of 6 columns

	country String	project_number String	commodity_co... String	period Date	beneficiary_qt Double	beneficiary_fcr Double
1	Syrian Arab Republic	200988	MIXBIS	2018-04-01	800.000	1 478 701,717

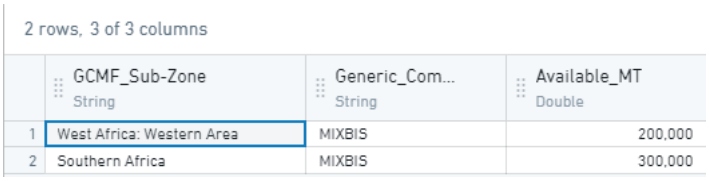
In this test line we attributed a fake shortfall to Syria in the amount of 800 MT of a certain commodity.



1 rows, 3 of 3 columns

	Origin_country String	COMMODITY String	RECIPIENT_CT... String
1	Turkey	MIXBIS	Syrian Arab Republic

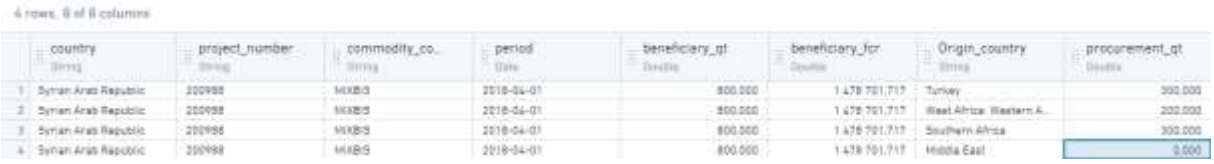
We knew by the data that there was only one supplier of MIXBIS (commodity iso name) for Syria. We also know that Syria falls under the scope of Middle East GCMF Sub-zone only. For that reason we added 2 fake lines to the GCMF list (that has the information about which Countries fall under which Sub-zones). In this list we added Syria as country under GCMF planning zone of West Africa: Western Area and Southern Africa.



2 rows, 3 of 3 columns

	GCMF_Sub-Zone String	Generic_Com... String	Available_MT Double
1	West Africa: Western Area	MIXBIS	200,000
2	Southern Africa	MIXBIS	300,000

We also knew through data analysis that the Middle East sub-zone didn't have any MIXBIS in-stock. If the coding was properly conducted we should expect for the dataset main_list_11, when checking Syria for the shortfall of MIXBIS, to display West Africa and Southern Africa GCMF Sub-zones and Turkey as possible suppliers. Furthermore, it should attribute a quantity of 800 MT (what is required as per the shortfall) minus what is in-stock in the GCMF Sub-zones to Turkey.



4 rows, 8 of 8 columns

	country String	project_number String	commodity_co... String	period Date	beneficiary_qt Double	beneficiary_fcr Double	Origin_country String	procurement_qt Double
1	Syrian Arab Republic	200988	MIXBIS	2018-04-01	800.000	1 478 701,717	Turkey	800.000
2	Syrian Arab Republic	200988	MIXBIS	2018-04-01	800.000	1 478 701,717	West Africa: Western A...	200.000
3	Syrian Arab Republic	200988	MIXBIS	2018-04-01	800.000	1 478 701,717	Southern Africa	300.000
4	Syrian Arab Republic	200988	MIXBIS	2018-04-01	800.000	1 478 701,717	Middle East	0.000

Attachment I: Data suit lead times

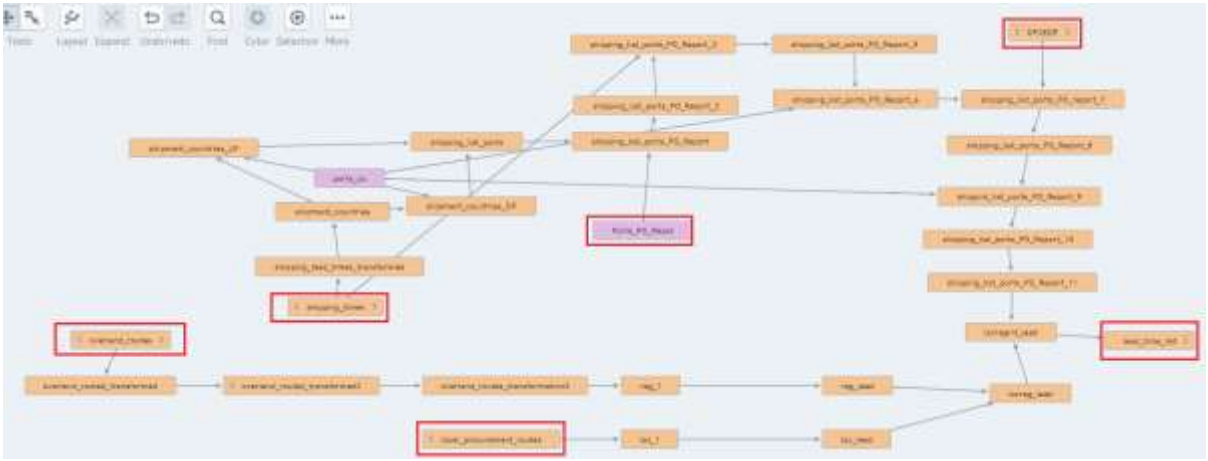


Figure 66: Snapshot of the data lineage for the lead times dataset

For the lead times that are done exclusively by land one can resort to the "local_procurement_routes" file, for transportation done solely within a country, and the "overland_routes" file for transportation done between 2 points that don't belong to the same country.

For the case of the International type of procurement involving movement of cargo between ports there wasn't any information available. To work around this problem the following methodology was adopted.

From the PO report one can extract the information regarding the supplier countries for the case of international procurement.

For that one needs to identify which PO lines are associated with International Procurement.

Since the PO report doesn't make the distinction between the 3 categories of procurement (Local, Regional or International) the following heuristic, although frugal in nature, was employed.

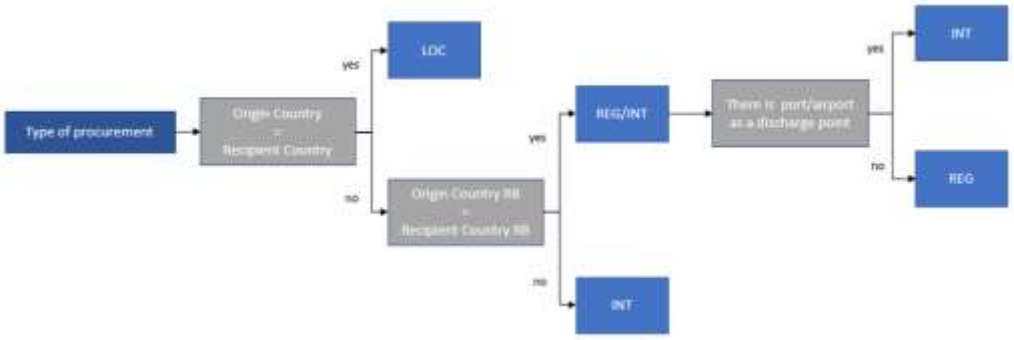


Figure 67: Decision tree for the type of procurement

After having identified each type of procurement a list of the historical supplier countries and the discharge points with them associated as well as the Beneficiary country was collected (e.g. When shipping from Turkey to Syria one historical shipping route is through Lebanon using the Beirut Port).

The discharge points that correspond to ports were determined by making a match between these and the discharge ports in the file "shipping_times".

After establishing the supplier country, the discharge point and the beneficiary country, one has to determine which ports are used by the supplier country.

Such can be achieved by looking at the ports' names on the file "shipping_times", since the name of the port is always proceeded by a comma and the iso code of the country in which the port is found (the iso code is a group of 2 letters that identify a country in which WFP operates e.g. Democratic Republic of Congo is CD).

Using the iso code we can allocate a group of ports to a given supplier country. Using this same file we can determine the lead times between the Supplier Country's port and the Discharge port.

In case the discharge port does not correspond to the beneficiary country another file, also from the data suit project is employed. The DP2EDP file (discharge port to extended delivery point) has the lead times from ports of discharge to warehouses in the same country or other countries. With this we just have to look up the EDP that corresponds to the beneficiary country given the discharge port.

Through these steps we have the lead times covered from the supplier country to the beneficiary country for the shipping of commodities involving transportation by sea.

Attachment J: Programming warning

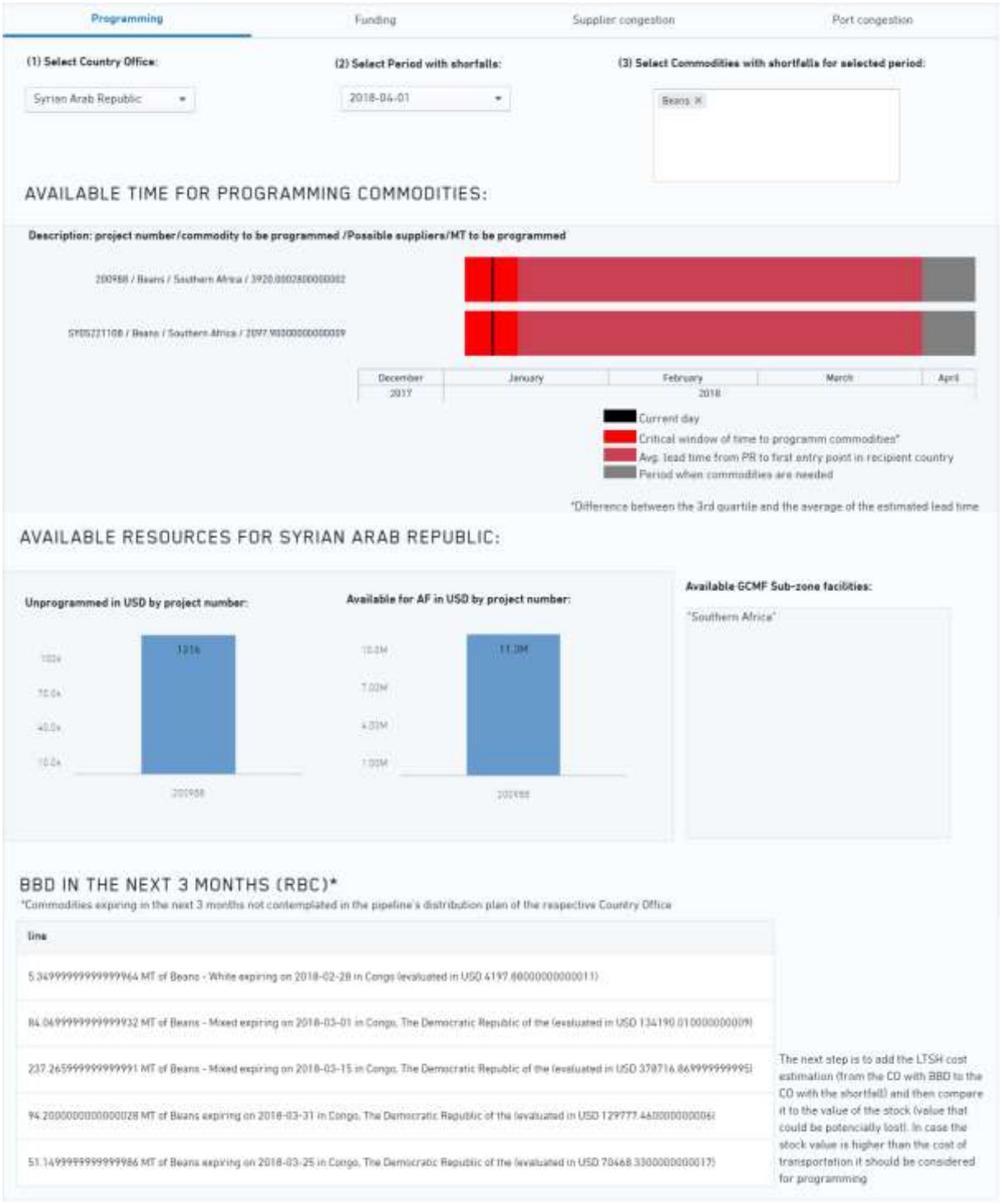


Figure 2: Programming warning platform