



Collaboration Managed Inventory Minimum/Maximum

CMI Min/Max

Ref LA05

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Global CMI Min/Max

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Executive Summary

This recommendation is based on two documents: Odette's *Vendor Managed Inventory* (VMI) and AIAG's *Inventory Visibility and Interoperability Min/Max Replenishment Business Process Future State* (IBP-1). It describes the basic business process model, corresponding functionality, responsibilities, and implementation steps for the Collaboration Managed Inventory Minimum/Maximum (CMI Min/Max) methodology.

Modern Supply Chain Management (SCM) concepts address important root causes of current limitations in logistics networks. Efficient build-to-order strategies and short time-to-delivery goals require fast and flexible supply networks. In this context, visibility/transparency is a prerequisite of high-level integration between customer and supplier and plays a central role.

The CMI Min/Max methodology represents one major process type in the family of consumption-based replenishment systems. This document sets a standard for the overall CMI Min/Max methodology and corresponding applications. The ultimate goal is to enable global, standardized use of CMI Min/Max applications from different software providers and marketplaces.

CMI Min/Max checks continuously whether actual or planned inventory levels are too high or too low in relation to demand. Suppliers will get near-real-time information to help them synchronize their production with customer consumption.

With CMI Min/Max implementations, there are cost savings due to the increased visibility between supplier and customer by reducing non-value-added and administration costs, making supplies more secure and efficient, and reducing inventory and transport costs.

This visibility allows inventory to be reduced on both sides. Still more savings can be realized if a continuous improvement approach is used. Once CMI Min/Max is implemented at a location, several things become very clear:

- Which parts have too much inventory – shown by excessive carrying costs, high obsolescence costs, and excess use of space.
- Which parts have too little inventory – shown by premium freight costs, line shutdowns, unplanned schedule changes, and overtime.
- Which suppliers are consistently maintaining the correct inventory levels – reflected in supplier performance measurements.

When a continuous improvement approach to CMI Min/Max is adopted, reviewing these items will affect Key Performance Indicators (KPIs) that, in turn, will impact the entire operation. CMI Min/Max essentially puts in place an upper and lower control limit on inventory levels. When the exceptions to the levels are reviewed, carrying costs, obsolescence costs, floor space utilization, line shutdowns, and overtime costs can be reduced. When the performance levels of suppliers are reviewed, capable suppliers can be identified. With these suppliers, inventory limits may be adjusted lower since there is a confirmed confidence in their capabilities. Because of the added visibility given to suppliers, they are allowed to add their insight into the process. Their ability to see the forecast and the daily usage by the customer will quickly give visibility to potential issues. A customer that moves to CMI Min/Max replenishment and does not solicit input from suppliers is doomed to failure.

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PHILOSOPHY OF SUPPLY CHAIN MANAGEMENT

The philosophy of Supply Chain Management (SCM) for CMI Min/Max embraces lean principles. The starting point for SCM activities is an in-depth understanding of the current situation in the supply network (e.g., material and information flows). On this basis, consistent and agreed cross-company business processes are established. In general, this requires an adaptation/re-engineering of internal business processes by the participants. Information Technology (IT) and the Internet play a major role to enable and support SCM concepts.

Core elements of the SCM philosophy are the following:

- Customer demand drives the whole inter-company supply network (synchronization, build-to order).
- A maximum of one stock location exists between customer and supplier (excluding aftermarket).
- The supply network increases reaction speed and flexibility.
- These concepts can be used at any level of the supply chain.
- Exception-based management (alerting) is based on workflows.
- Integrated inter-company processes are needed to collect and share relevant data allowing for visibility and transparency.
- Information relevant for decision making is updated in an appropriate time period, allowing for quick responses.
- Scenarios can be simulated due to the global availability of information.
- Win-win customer and supplier relationships are enabled.
- Finding the root causes is the focus rather than merely curing the symptoms.

1.0 INTRODUCTION TO CMI MIN/MAX

The global Collaboration Managed Inventory (CMI) Minimum/Maximum (Min/Max) project was initiated as a joint effort between the Automotive Industry Action Group (AIAG) and Odette to elaborate a harmonized CMI as a common standard for global use in the automotive industry. This document--*Collaborative Managed Inventory for Min/Max*--is the first in a series of replenishment documents that will be developed. In the fall of 2005, AIAG and Odette will begin the CMI Kanban document.

1.1. Business Opportunity

The AIAG Inventory Visibility and Interoperability (IV&I) project took an extremely conservative approach by examining only reductions in premium freight and carrying costs of inventory. At a summary level for the industry, the analysis concluded that an annual savings of \$255 million could be realized by using the inventory visibility tools in CMI Min/Max. Odette agrees that the European automotive supply chain can expect similar benefits.

1.2. Problem Statement

Currently, there are no standard global CMI Min/Max models and related message sets that cover the replenishment of inventory for automotive supply chain management. Until now, there have been only country- or company-specific guidelines for such business process.

Without a global standard, suppliers will face problems and complexities in handling different customer-driven Min/Max business process models and related systems.

1.3. Definition and Process Description

CMI Min/Max is a concept and process for consumption-based supply chain management. It requires the supplier to maintain inventories within predefined and mutually agreed thresholds based on a Min/Max range. The supplier can freely deliver within the indicated Min/Max range.

The basic requirements for a successful CMI Min/Max process are a good partnership, cross-company information sharing, and transparency close to real-time. Therefore, communication and visualization of the Min/Max range, the inventories, and the planned consumption of the customer are necessary.

CMI Min/Max is not appropriate for certain parts. To help determine if the CMI Min/Max process is right for your company, see section 6.1 Preliminary Analysis.

1.4. Expectations of Parties Involved

Supplier

The supplier expects that the customer will provide the necessary information in a timely manner, taking into account:

- Defined preparation time
- Inventory levels
- Planned consumption information

Existing contractual agreements (including flexibility agreements) between customer and supplier will remain in place.

Customer

The customer expects the supplier to replenish the required quantity of parts within the contractual agreement.

Third-Party Logistics (3PL) Provider

The logistics supplier, where involved, expects the customer and/or supplier to establish an agreement with clear responsibilities concerning service, e.g., transport and storage of items.

1.5. Basic Principles and Information Flows

CMI Min/Max is based on and controlled using the following information:

- An assumption that the customer's actual demands are the same as planned consumption. Using gross demand (Bill-of-Material explosion of the production plan without further parameters) is the preferred practice. If gross demand is not available, net demand can be used; however, the full benefits of CMI Min/Max will not be achieved.
- Actual customer inventory and daily consumption
- Actual in-transit inventory
- Actual supplier finished-product inventory (optional)
- Agreed minimum and maximum stock levels (fixed quantities or dynamic expression as days of stock)

Based on these principles and information flows, the functional process is as shown in Figure 1.

Basic Information Flow in CMI Model 1b: 3PL as Subcontractor of Customer (customer owns material in 3PL warehouse)

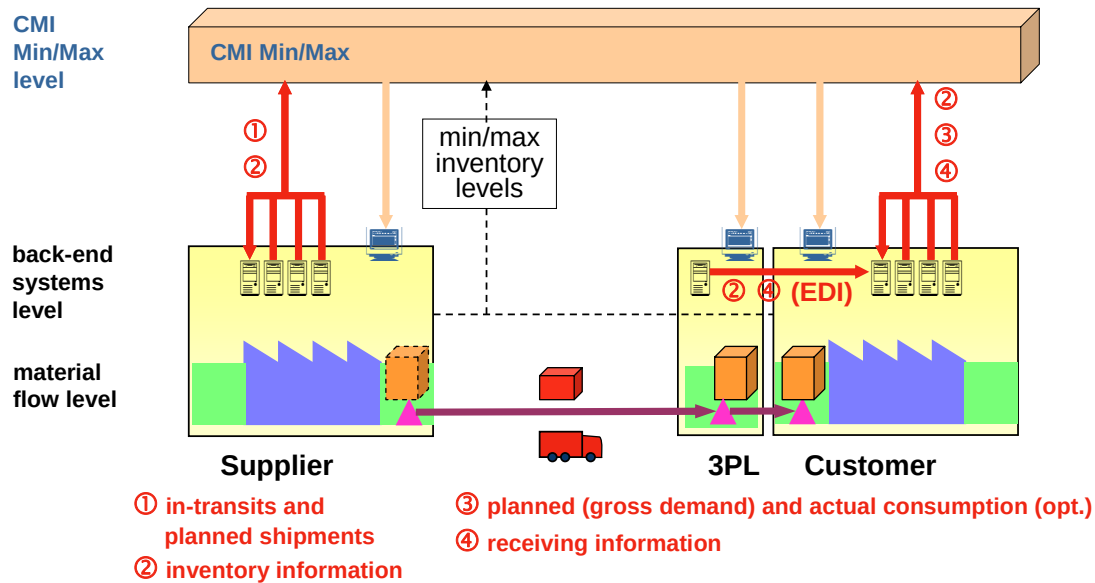


Figure 1: Basic Principles and Information Flows

1.6. Scope of CMI Min/Max and Limitations

Figure 2 shows that CMI Min/Max is a replenishment methodology, among others (i.e., call-off and Kanban), that can be realized independently of stock ownership and terms and conditions of transport.

The “Concept Cube” Scope of CMI and differentiation to related concepts

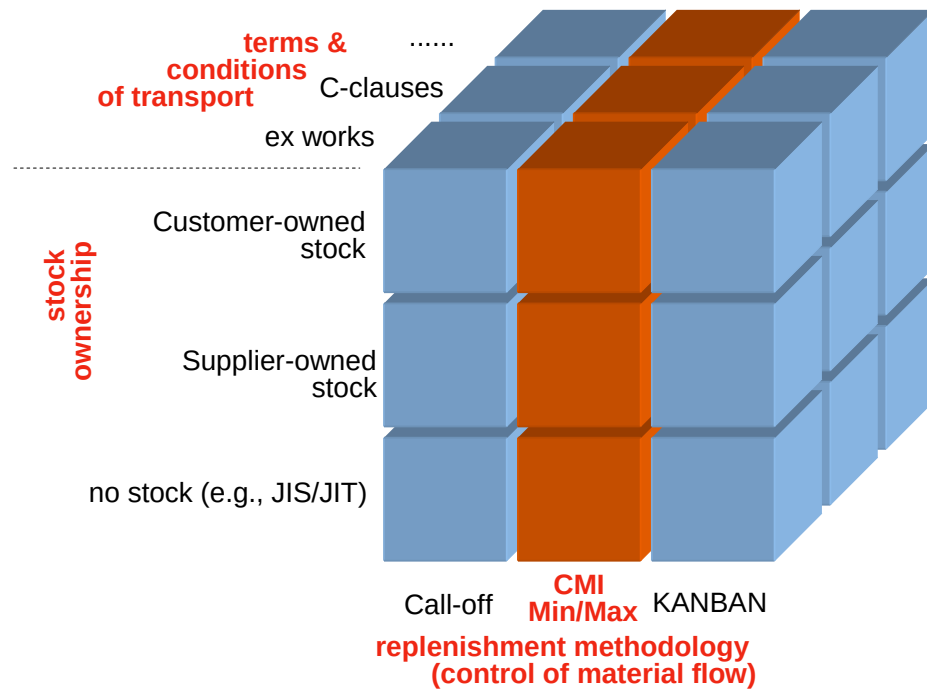


Figure 2: Concept Cube

Definitions

CMI as a replenishment methodology is embedded in a multi-dimensional concept environment. The terms in the Concept Cube in Figure 2 are explained in detail below.

Stock Ownership

The consignment stock concept comprises the following features:

- Supplier is the owner of material in a warehouse that is normally close to, or even within, the customer plant.
- Customer can use stock without prior notification.
- Transfer of ownership is agreed between customer and supplier.

Consignment stock is an option for CMI Min/Max.

Terms and Conditions of Transport

Terms and conditions of transport, International Commercial Terms (INCOTERMS), can be found at <http://www.iccwbo.org/incoterms/preambles.asp>.

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Replenishment Methodology

CMI Min/Max is a replenishment methodology. Other well-known replenishment methodologies are these:

Call-Off Concept (MRP-driven)

- Customer determines fixed quantity and times (day) for deliveries (push).
- Customer determines fixed quantity and time (hour) and sequence of part numbers for deliveries (push).

Kanban Concept (Consumption-driven)

- Replenishment signal occurs after every consumption (pull).
- Delivery quantities and times are predefined based on consumed quantity (supplier reacts).
- Forecast / planned consumption is not taken into account for shipping purposes.

1.7. Goals and Benefits

The general goals and the expected benefits of the CMI Min/Max process are as follows:

- Reduced non-value-added activities and administration
- More secure and efficient supply
- Lower inventory and transport costs

How to identify and quantify the benefits and how to share them among the supply chain partners is still an open issue.

Reduced Non-value-added Activities and Administration

- Reduced significant effort / cost for the supplier in following volatile demand (ad hoc rescheduling, trouble shooting, extra freight, overtime, idle time, etc.).
- Reduced manual effort and responsibility for the customer (automated provision of updated planned consumption [gross demands] and inventory information).
- Reduced effort of handling and administration for both the customer and supplier.
- Opportunity for the supplier to optimize production scheduling (lot sizes).

More Secure and Efficient Supply

- Supplier is responsible for guaranteeing customer supply and replenishment.

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- Early warnings enable tracking and controlling of the whole process.
- Ad hoc activities and related effort and cost are minimized.
- All supply chain processes will become more robust with regard to interference
- Prevention of stock-out and over-supply situations provides for smooth and secure supply with minimal inventory.
- Transparency, flexibility, and synchronization between customer and supplier are increased.

Reduced Inventory and Transport Costs

- Improved inventory levels in the selected part of the supply network.
- Reduced total inventory (safety stock, incoming material, production material, etc.) in the supply chain.
- Reduced transport and freight costs by optimization of transport frequency and lot sizes, and transport planning.

1.8. Further Considerations

- Multi-Sourcing: CMI Min/Max is not limited to single-sourcing. Prerequisites for using multi-sourcing are the following:
 - Separation of supplier-specific inventory information (goods-in and real consumption).
 - Separation of planned consumption per supplier (quotas or percentages).

It is advised that a process to ensure the reconciliation between real and planned consumption according to the quotas be in place in the ERP system.

- The main focus is on direct material for series production; however, other products may also be controlled by CMI Min/Max.
- The predictability, reliability, and relative stability of the demands are important. CMI Min/Max does not resolve allocation problems or very volatile demands.
- All data must be up-to-date and correct, and sent on a regular basis, e.g., daily.
- Flexibility agreements should be committed.
- Bilateral agreements regarding transport are essential (frequency, minimum lot sizes, etc.).
- CMI Min/Max and Pick-Up processes by the customer are not complementary processes.

1.9. Tracking / Alerting / Early Warning

Based on all the information flows described above, an alert system is necessary to provide an early warning of issues requiring corrective action. The alert processes are described and explained in section 3.5.

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2.0 BUSINESS PROCESS DESCRIPTION

2.1. Operative Process

The following schematic shows the cyclical operative process with the different functions, the necessary and resultant data, the responsibilities, and the interaction between the CMI Min/Max level (e.g., inventory visibility tool) and the back-end system level. In Figure 3, the functions are contained in the box arrows and the databases are shown in the cylinders.

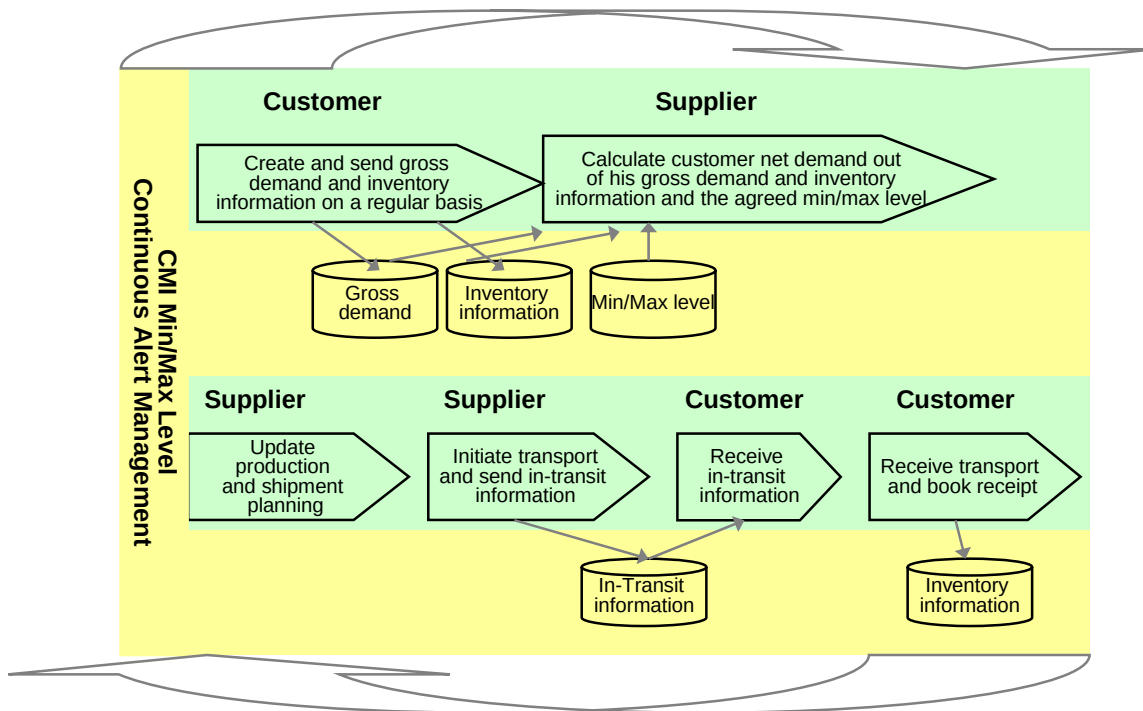


Figure 3: Overview of the Operative Process

Figure 3 is an overview of the business process. Figures 4-7 on the following pages depict several possible scenarios of the process.

2.2. Business Cases

Basic Information Flow in CMI without 3PL

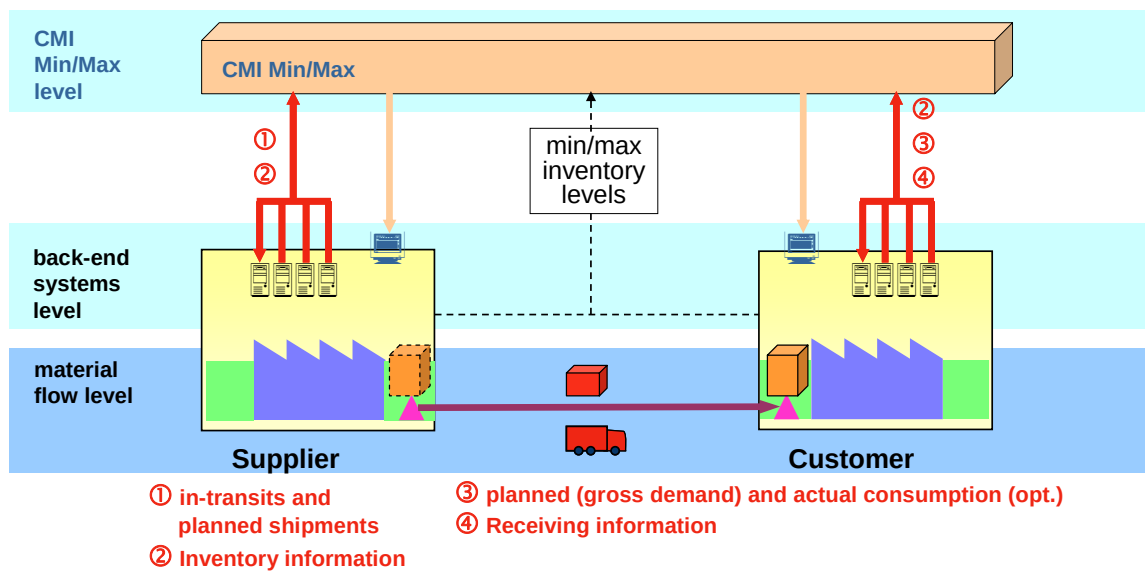


Figure 4: Basic Information Flow without 3PL

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Basic Information Flow in CMI Model 1a: 3PL as Subcontractor of Supplier (supplier owns material in 3PL warehouse)

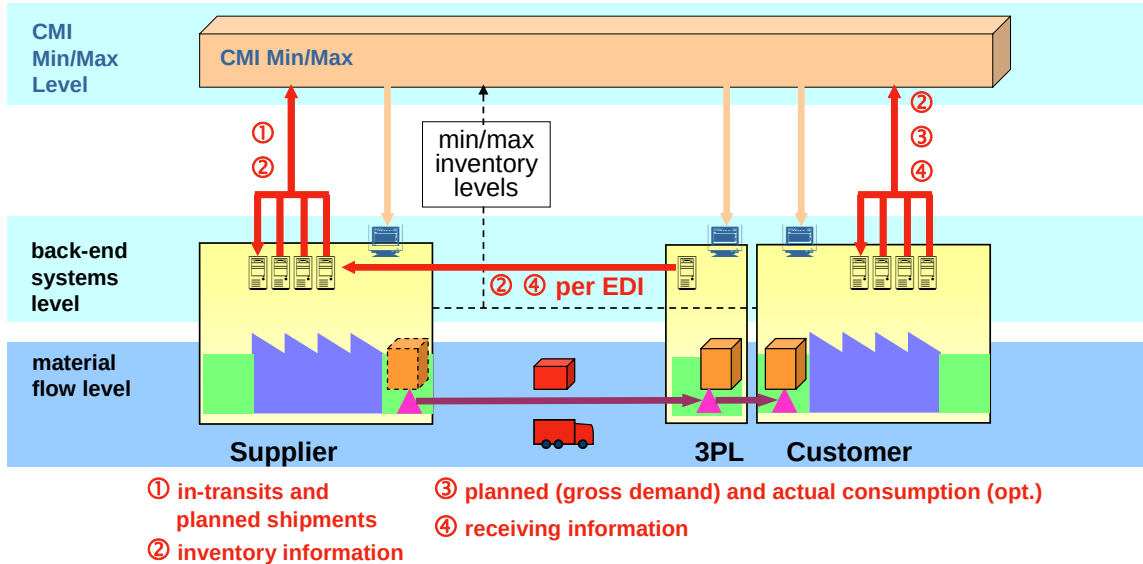


Figure 5: Basic Information Flow - Model 1a

Basic Information Flow in CMI Model 1b: 3PL as Subcontractor of Customer (customer owns material in 3PL warehouse)

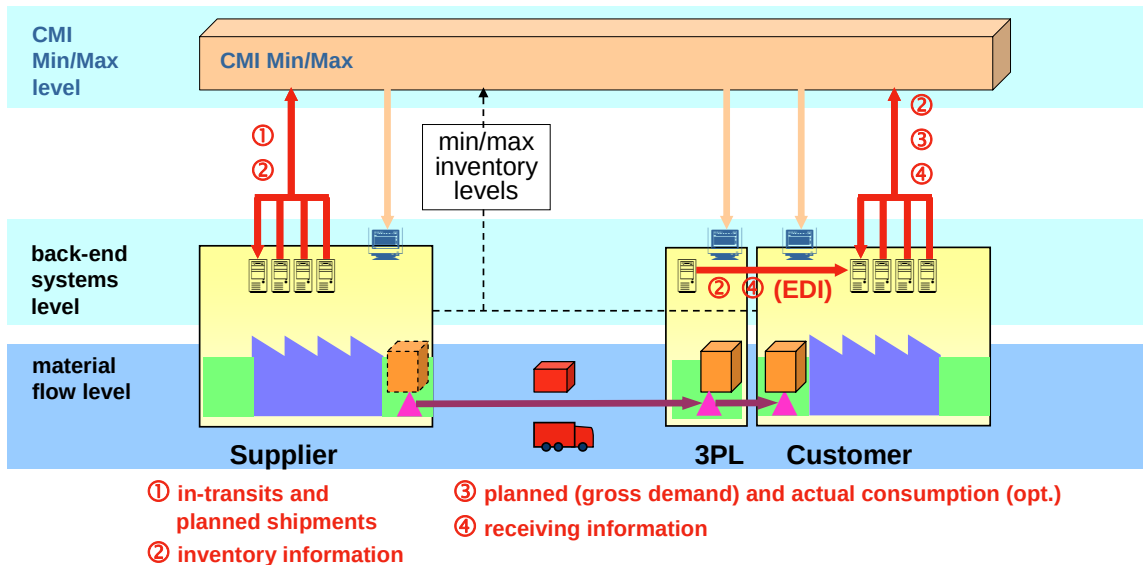


Figure 6: Basic Information Flow - Model 1b

Basic Information Flow in CMI Model 2: Direct Involvement of 3PL

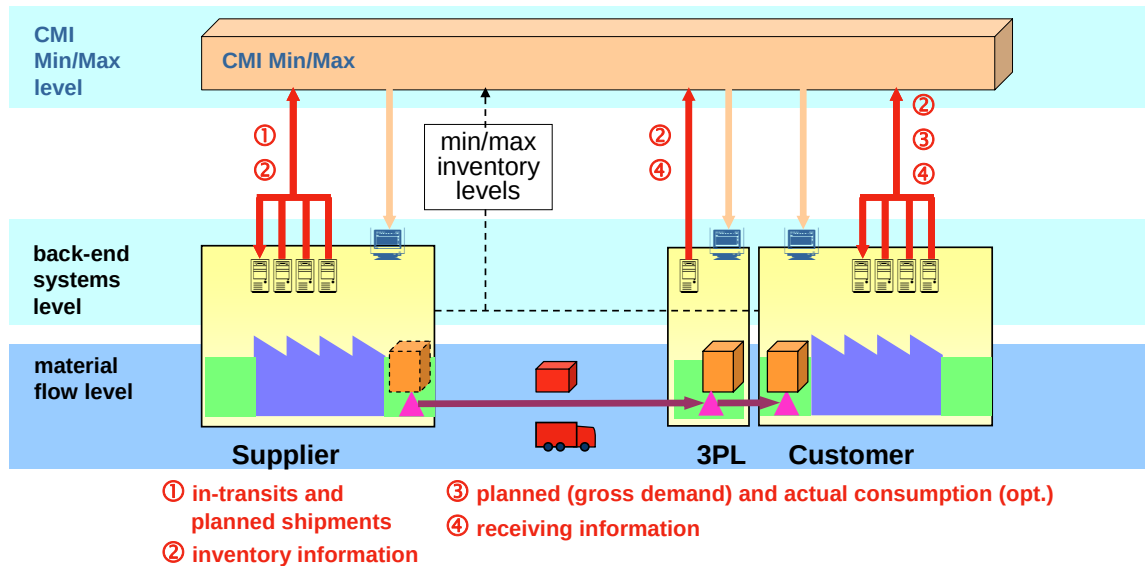


Figure 7: Basic Information Flow - Model 2

3.0 FUNCTIONALITY

3.1. Basic Functions

3.1.1 Visibility and Consistency of Information

CMI Min/Max inventory information should be provided as frequently as possible; at a minimum of once a day in order to show up-to-date inventory levels.

CMI Min/Max inventory relationships (customer, supplier [optional], 3PL), receipts, planned consumption, and materials in transit (ASN) must be synchronized as frequently as possible; at a minimum of once a day. The synchronization would include:

- Materials in transit should be synchronized with receipts.
- Receipts are synchronized with CMI Min/Max inventory figures.
- Planned consumption is synchronized with CMI Min/Max inventory figures.
- Optionally, materials in transit are synchronized with finished goods inventory at the supplier.

3.1.2 Matching Advanced Ship Notices (ASNs)

Matching delivery notes / ASN with goods received

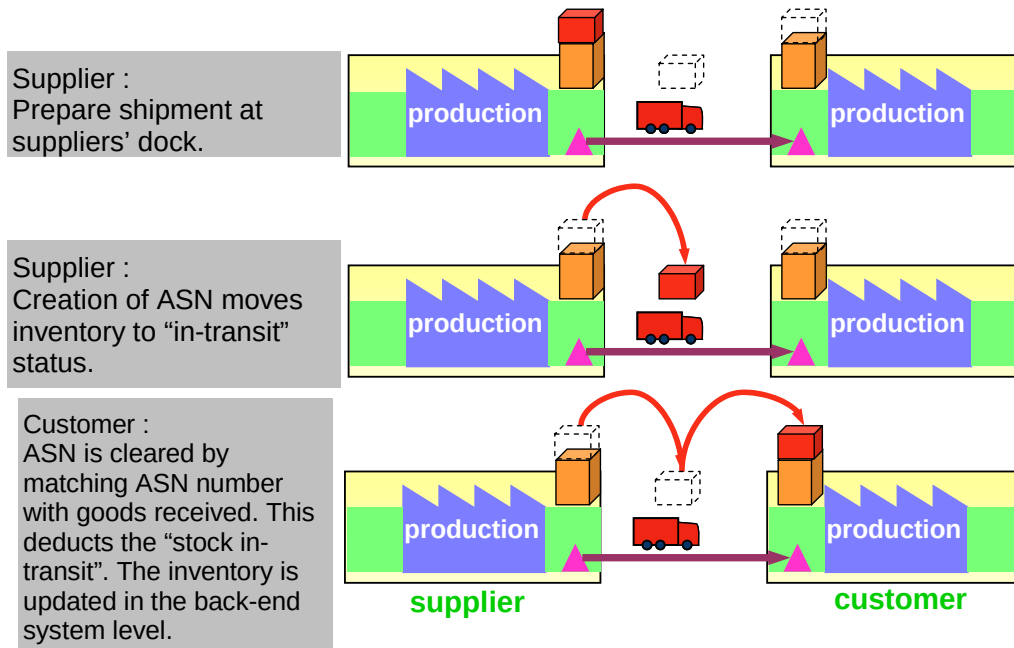


Figure 8: Matching Delivery Notices / ASNs with Goods Received

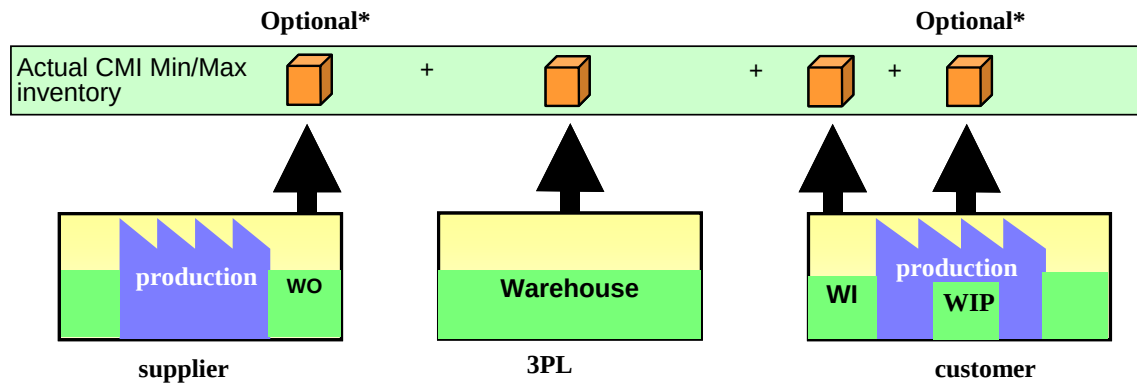
3.1.3 Definition of Inventory

Actual CMI MIN/Max Inventory includes the following:

- Stock in customer-specified locations (e.g., customer inbound warehouse, 3PL warehouse close to the customer site)
- Supplier stocks in consignment warehouse
- Optional: Customer line buffer and/or Work-In-Process (WIP)
- Optional: Stock in supplier-specified locations (e.g., inventory of finished products at supplier shipping)

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Definition of Inventory



*Optional :
including supplier's
finished goods/
customer's WIP into
Actual CMI Min/Max
stock calculation

Figure 9: Definition of Inventory

Blocked stocks or items on a quality hold status (long-term quality problem) are not included in CMI Min/Max stocks but should be communicated to the supplier.

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3.1.4 Definition of Daily Consumption Information

Daily Consumption information is optional. However, the customer and supplier will benefit from the capability to check the calculated consumption against the planned consumption.

Calculation of consumption in a 24-hour period:

$$\begin{array}{r} \text{opening stock} \\ + \text{ stock receipts} \\ \text{ending stock} \\ \hline = \text{consumption} \end{array}$$

Comment:

Daily calculated consumption (versus actual consumption) should not be used directly for invoicing/self-billing processes because inventory adjustments due to damages or scrap, for example, are not considered.

3.2. Customer Functions

3.2.1 General Rules

The customer notifies the supplier of the planned consumption. The supplier must ensure an adequate supply of goods based on the inventory level settings stipulated in the mutually agreed minimum range of coverage. The minimum level depends on the following factors:

- Planned consumption
- Production lead time
- Transport lead time
- Container and/or minimum delivery quantity (lot size)

Maximum level settings will be agreed in order to limit the value or space related to the goods in inventory.

The customer may notify a suggested delivery quantity, which will help the supplier to automate the shipping process. The suggested delivery quantity is the difference between the maximum inventory level and the total sum of stock at the customer and in-transit, taking into account the container or minimum delivery quantity (lot size).

The customer and supplier are required to establish a contractual agreement that specifies when the maximum level is exceeded. More commonly, the customer is allowed to return the goods or to charge the supplier's account.

Suppliers must be given instructions whether to respond to every alert or only critical alerts and on the time fence for responding to alerts.

Typically, the supplier is responsible for the transport for CMI Min/Max. However, if the customer is responsible for the transport, the customer will define the following:

- Date and time when the truck regularly leaves the supplier's plant
- Transport lead-time from supplier to customer

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3.2.2 Min/Max Level Considerations

Min/Max - Level Calculation:

Minimum and maximum inventory levels must be agreed mutually by the customer and the supplier.

The following processes should be reviewed by the customer before introducing a Min/Max system:

- Forecast data accuracy
- Level of inventory accuracy
- Container / lot / minimum delivery quantity
- Inventory data update frequency

A number of approaches may be used to determine the size of minimum and maximum inventory levels. The levels may be set manually or automatically by a download from an ERP system, and measurement may be in units or days on-hand.

The following gives example calculations to support the Min/Max parameters:

Average Planned Daily Usage (ADU) =	$(\text{Forecast total} / (\text{actual number of weeks with } > \text{ zero planned usage})) / 5$
Min Calculation =	Days of Safety Stock * ADU
Max Calculation =	Min + (5/Weekly ship freq.*ADU) + (Transit days * ADU)
Min Calculation = (with Container Qty)	Above Min Calculation rounded up to the nearest Container Qty
Max Calculation = (with Container Qty)	Above Max Calculation rounded up to the nearest Container Qty

It is recommended that these CMI Min/Max inventory levels remain static for an appropriate period and be reviewed on a periodic basis (monthly). Also, consider the supplier production lot size in relation to warehouse capacity in order to determine the maximum level.

3.2.3 Planned Consumption

Within the CMI Min/Max process, the customer provides planned consumption information on a daily and weekly basis (to be agreed by customer and supplier), also known as gross demand. Gross demand is the result of the MRP without considering inventory information and lead times.

The planned consumption does not include material on-hand at the customer or material in transit. The schedule states the actual date and time of planned consumption, either for production or for shipment purposes.

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Planned consumption does not control the shipment from the supplier to the customer. Only the actual or projected minimum and maximum inventory levels control these shipments.

Planned consumption that has not been used by the defined date / time (e.g., because of production rescheduling, tool breakdown, etc.) must be visualized / communicated to the supplier using one of the following concepts:

Preferred process:

A new planned consumption will be communicated (assuming a daily MRP run in the customer ERP system will be undertaken before synchronizing the planned consumption and stock movements to the supplier).

Work-around process:

Planned consumption with past dates must also be visualized in the CMI Min/Max level (assuming no daily MRP run in the customer ERP system will be undertaken).

Handling of backlog situations should be agreed between customer and supplier.

3.3. Supplier Functions

3.3 1 General Rules

Shipping to the Customer

The supplier's responsibility is to keep the customer's inventory levels between the minimum and maximum inventory levels, within the limits of responsibility of the forecast (i.e., projected inventory levels).

The supplier is permitted to ship to the customer only those parts that will maintain the inventory below the maximum level. Conversely, the supplier must ensure on-time shipment that guarantees the inventory will not fall below the minimum level.

If the inventory level drops below minimum, there will be an alert. The supplier must respond to this immediately, in accordance with the planned consumption of the customer.

Shipping frequency and shipping windows may remain as previously agreed with the customer before the introduction of CMI Min/Max. The supplier should continue to ship on the same days and times, for example, Tuesdays and Thursdays at 12:00 noon. The main difference between the outgoing "push" method of shipping and the CMI Min/Max approach is that the supplier should now plan the shipment based on the actual and projected Min/Max stock at the warehouse.

Special Transports (Expedited Freight)

The responsibility for special transport caused by quality issues, engineering change, deviation from routing instructions, etc. remains the same as prior to CMI Min/Max and should be included the respective agreement between customer and supplier.

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3.3.2 Optimizing the Supplier's Production and Transportation Planning

CMI Min/Max offers various options to meet the requirements as to how much and when to replenish. The diagram in Figure 10 illustrates two extremes:

1. Ship immediately to the maximum allowed quantity.
2. Ship at the last possible date to keep inventory at the minimum level.

The preferred method is to have suppliers ship to the maximum level for each shipment occurrence. This should match with consumption of the part in production. Shipping to a minimum level each time does not necessarily help in achieving inventory or transportation goals. If the maximum level is set too high, then a review needs to be done with the supplier to adjust to the correct level.

Implication Regarding Production and Transportation Planning

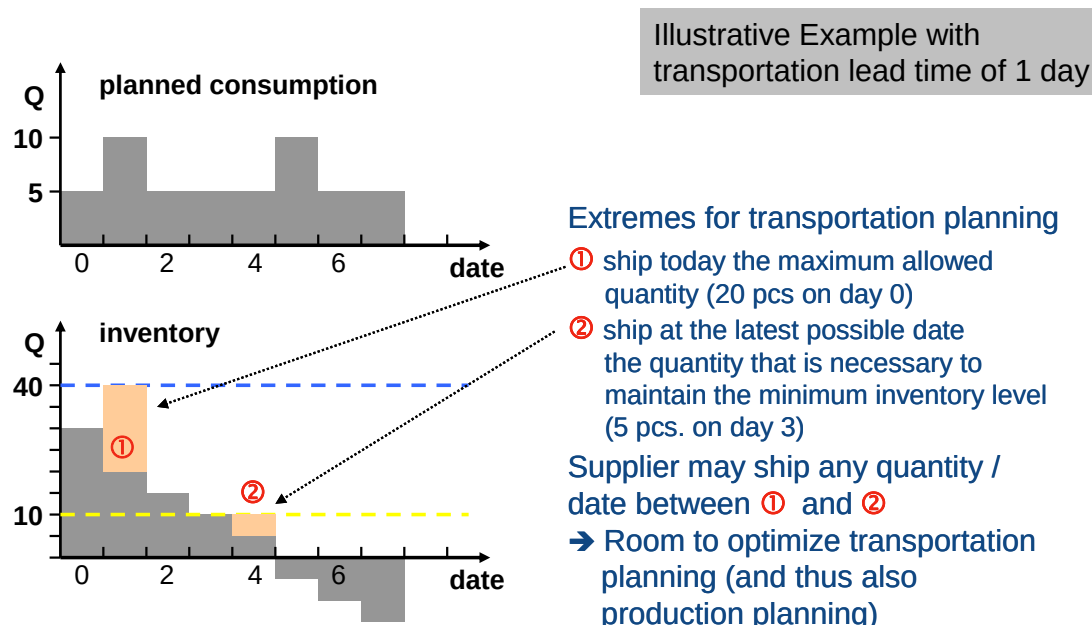


Figure 10: Example with Transportation Lead Time of 1 Day

3.4. Engineering Changes

3.4.1 Process and Method of Change Management

Change Management and Impact on CMI Min/Max

The Change Management process can be undertaken in two ways. The first approach is to continue to request shipment of the old product up to a given date and then switch the shipping request to the new product. This is called “fixed input into production.” The alternative approach is to continue to supply and use the old product until they are all consumed and then switch demand to the new product. This is known as “flow into production.”

Figure 11 shows the effect of each approach on the CMI Min/Max inventory profile.

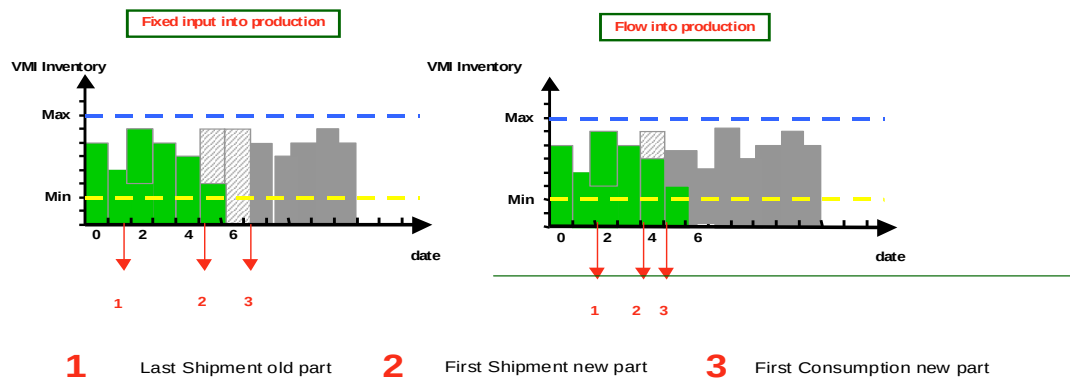


Figure 11: Change Management and Impact on CMI Min/max

At a parts level, change management can be achieved either by issuing a new part number for the incoming part or by revising the issue level of the existing part number.

The visualization of change management-specific information--such as the match of old/new part number, the part number and revision level, and controlled inventory maintenance--is a key requirement for a successful CMI Min/Max process.

Management of engineering changes is not the main focus of CMI Min/Max.

Recommendation

- Management of the changed / new part numbers within the CMI Min/Max process is optional.
- The customer and supplier must contract a bilateral agreement regarding the use of changed or new parts within the CMI Min/Max process.
- Changed or new parts should be identified as such in the CMI Min/Max level and in the ERP system.

3.5. Alert Definition and Management

One of the biggest changes with CMI Min/Max is the exception-based management capabilities. When certain thresholds are reached, most tools will send an alert to the supplier and customer. With this comes the possibility of “alert overload.” Care must be taken that suppliers (and customers) are alerted only when something critical has happened. What constitutes “critical” must be defined within each company. There must be a clear guideline communicated to suppliers for the process of handling alerts. Areas to cover are the following:

- Alerts to be used
- What and when critical limits are to be reviewed
- Required response time for alerts
 - Suppliers must be given instructions on the time fence for responding to alerts. In addition, specify whether every alert should be responded to or only the critical ones..
- Supplier contact information maintenance
 - Responsibility for the supplier’s contact information must be given to the supplier. Because alerts are sent for critical events, it is important that the message is sent to the correct person.

3.5.1 Recommended Alerts

Below are recommended alerts that could be handled by the supplier:

- Inventory below the Min-Level / above the Max-Level.
- Significant change of planned consumption (e.g., deviation exceeds agreed-upon flexibility).
- No data transmitted from ERP to the CMI Min/Max level for a mutually agreed-upon time (recommended: at least once a day).
- Overdue arrival (e.g., no matching of delivery notes / ASN with goods received within the agreed-upon time frame).
- Engineering change notification (optional).

Section 3.5.2 describes each of the above in more detail.

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3.5.2 Alert Definition and Calculation

Inventory below Min / above Max-Level

Alert Definition

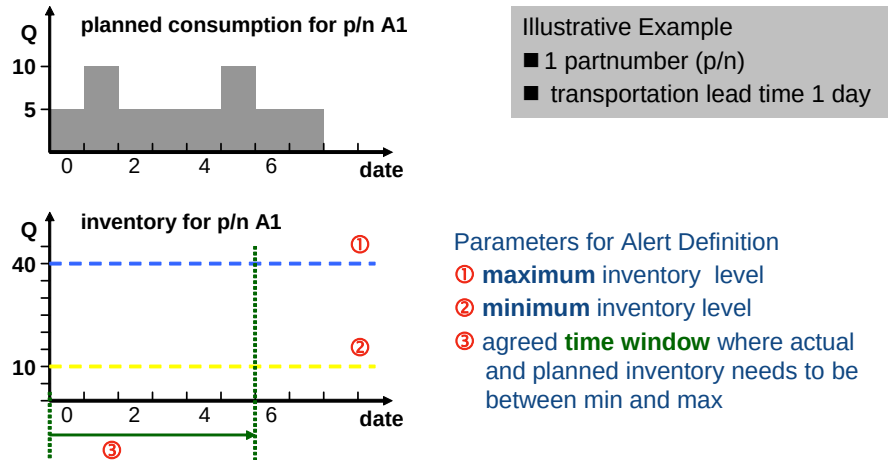


Figure 12: Alert Example

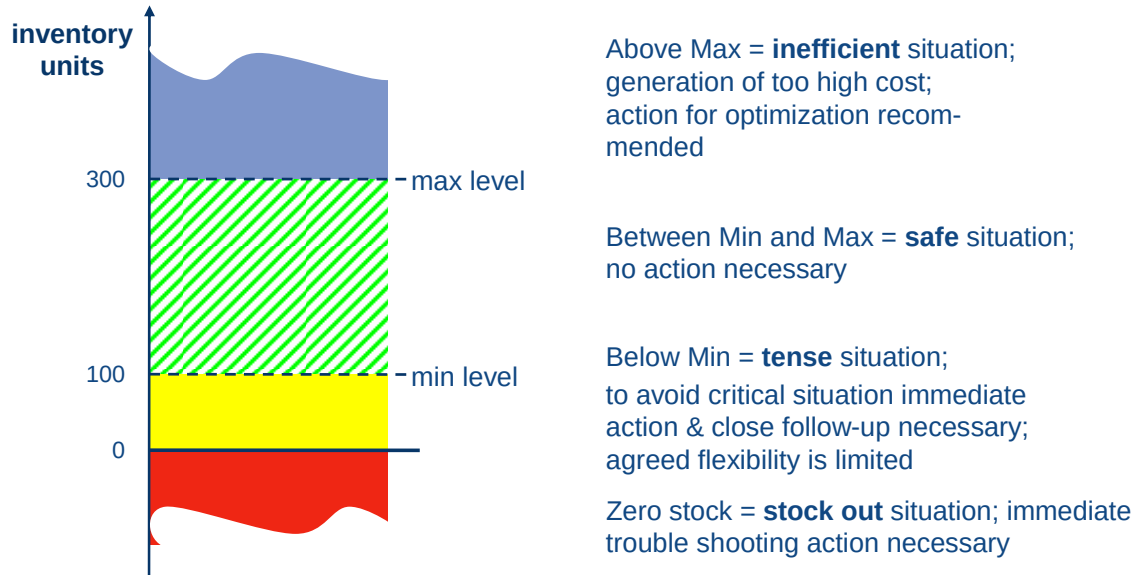
Calculation

- stock in-transit
- planned shipments (optional)
- agreed min/max thresholds
- agreed time window where future inventory must be within min/max bandwidth
- mathematical calculation based on several parameters (example in section 3.2.2)
- absolute number, e.g., units, or
- dynamic expression, e.g., days of inventory

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Basic Alert Definition

Alert Definition for Inventory Triggers



Note : Colors are specified in the CMI Min/Max application

Figure 13: Basic Alert Definition

The following figures (14-16) review the alert calculations for inventory for below min and above max level considering in-transit inventories and planned shipments.

Alert Calculation based on projected current Inventory

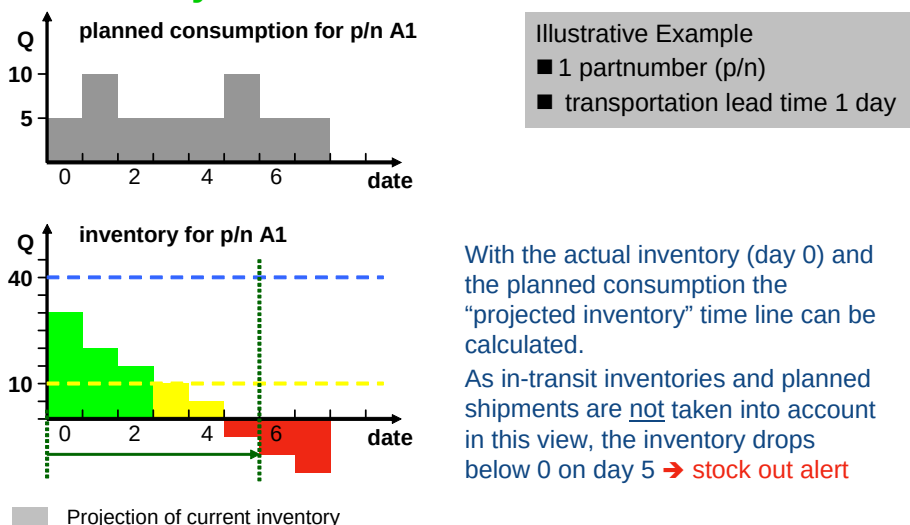


Figure 14: Alert Calculation for Projected Inventory Based on Stock-on-hand

Alert Calculation including in-transit Inventory

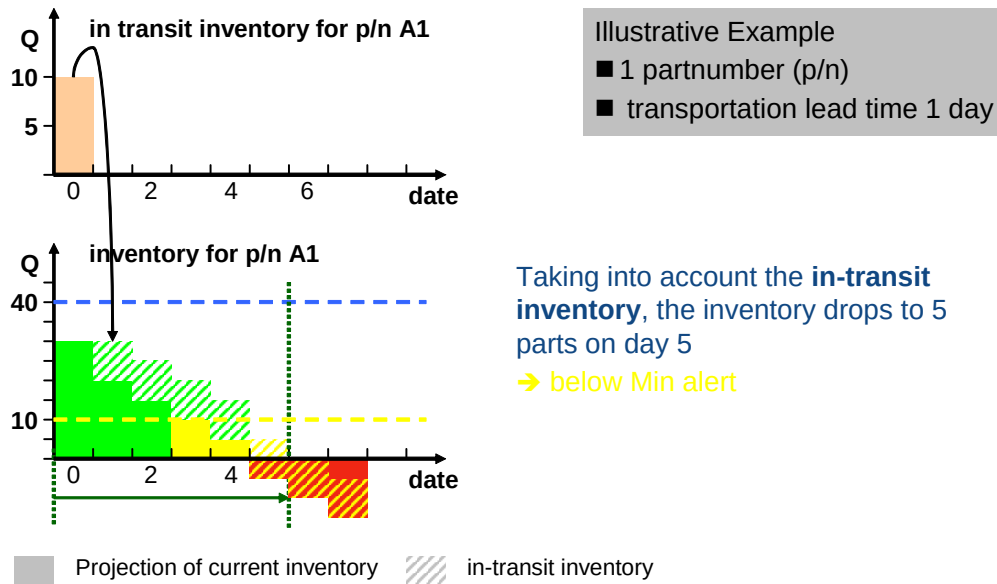


Figure 15: Alert Calculation for Projected Inventory Including In-transit Inventory

Alert Calculation including Planned Shipments

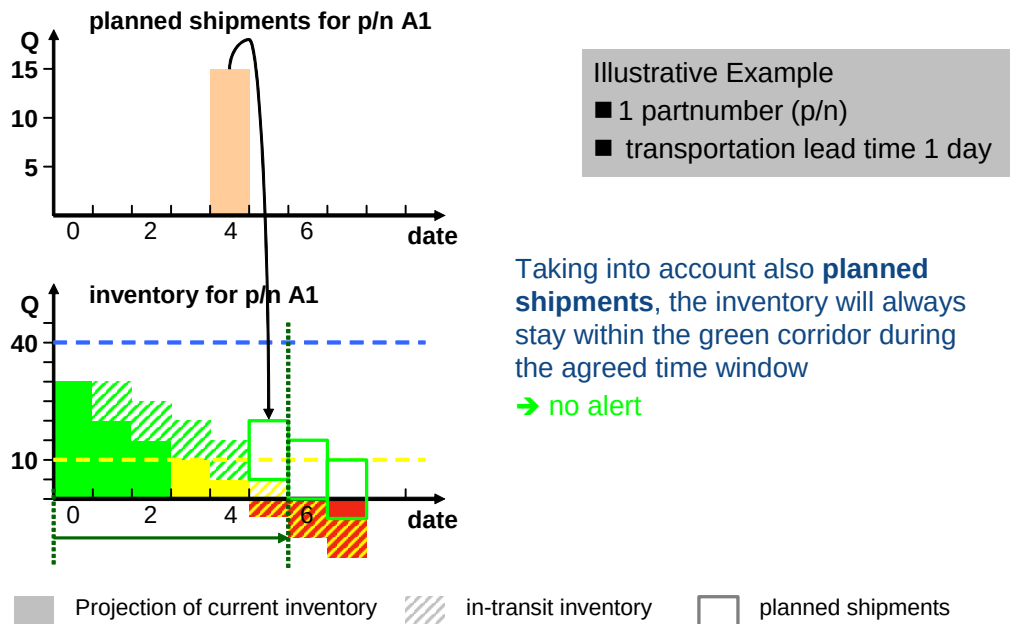


Figure 16: Alert Calculation for Projected Inventory - In-transit and Planned Shipments

Significant change of planned consumption

An alert may occur when the customer communicates a significant change of planned consumption. The basis for activating the alert is mutually agreed flexibility margins (e.g., plus or minus 20 percent of monthly demand).

Following are two basic alternatives to alert significant changes of planned consumption.

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Alternative 1: The alert will occur when the planned consumption will go over or under one defined flexibility margin (e.g., plus or minus 20 percent of monthly demand).

Alert Calculation for significant change of consumption

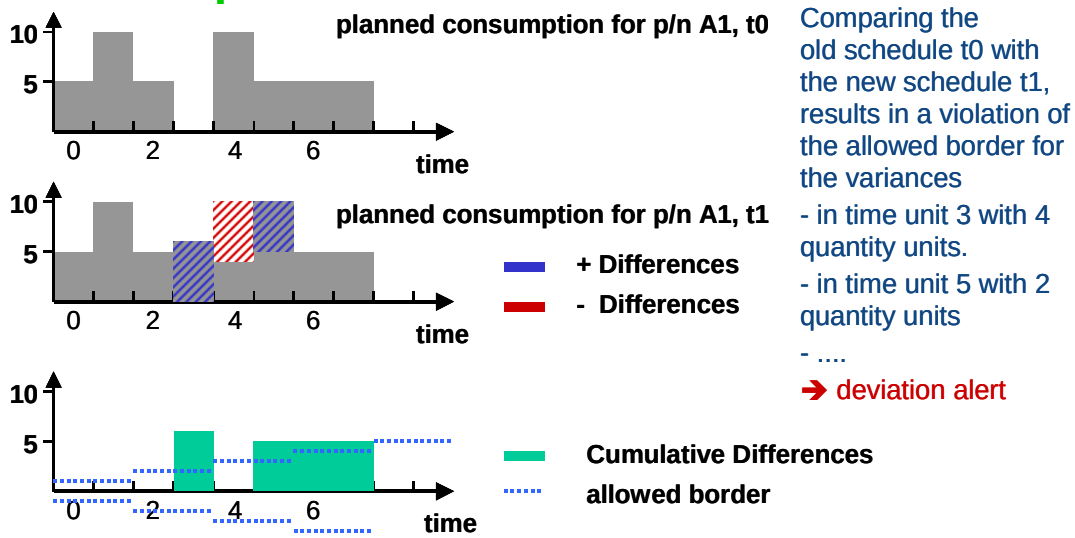


Figure 17: Alert Calculation for Significant Change of Consumption - Alternative 1

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Alternative 2: The alert will occur when the planned consumption will go over or under two defined flexibility margins (e.g. plus or minus 20% of monthly demand).

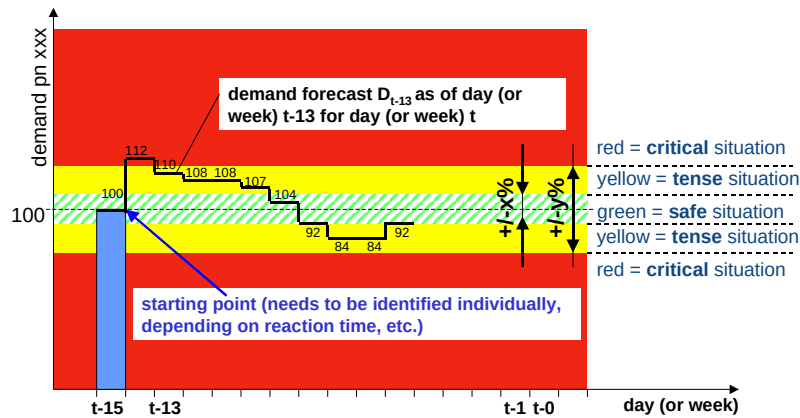


Figure 18: Alert Calculation for Significant Change of Consumption - Alternative 2

Based on the defined synchronization between inventory and consumption information, the alert gives warning to the supplier that, due to missing transmissions, data integrity is not ensured.

Overdue Arrival

- Realistic in-transit times are agreed for supplier deliveries. An alert is given when the due date of receiving has expired.
- The alert gives the customer and the supplier a warning that the planned transit time is overdue and hence the possibility of a stock implication or stock-out occurrence.
- Possible explanations can be that the receiving and the ASN are not correctly booked and matched or the ASN has not been transmitted correctly.
- Both customer and supplier must agree on what period of time an overdue arrival of in-transit inventory will be included in the inventory calculation.

Trigger Point for an Alert

- Close to the synchronization time of planned consumption, inventory levels and goods receiving

Engineering Change Notification

For information on engineering change notification, please refer to section 3.4.

3.5.3 Alert Management, Communication, and Workflows

CMI Min/Max supports the principle of exception-based management. Hence, the system needs to recognize whether a situation (e.g., demand / inventory) is “normal” or “exceptional.” Therefore,

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thresholds must be defined (e.g., minimum and maximum days of inventory). Care should be exercised in setting thresholds to avoid overburdening trading partners with too many alerts or emails.

Alert Generation

Alerts inform the persons responsible to take corrective action on those exceptional situations that are visualized in the alert board / action item board of the CMI Min/Max application (see Table 1). Table 1 illustrates what an alert board may look like. This example demonstrates a common view by customer and supplier in an alert situation.

Alert Generation, Alert Board and Action Item Board

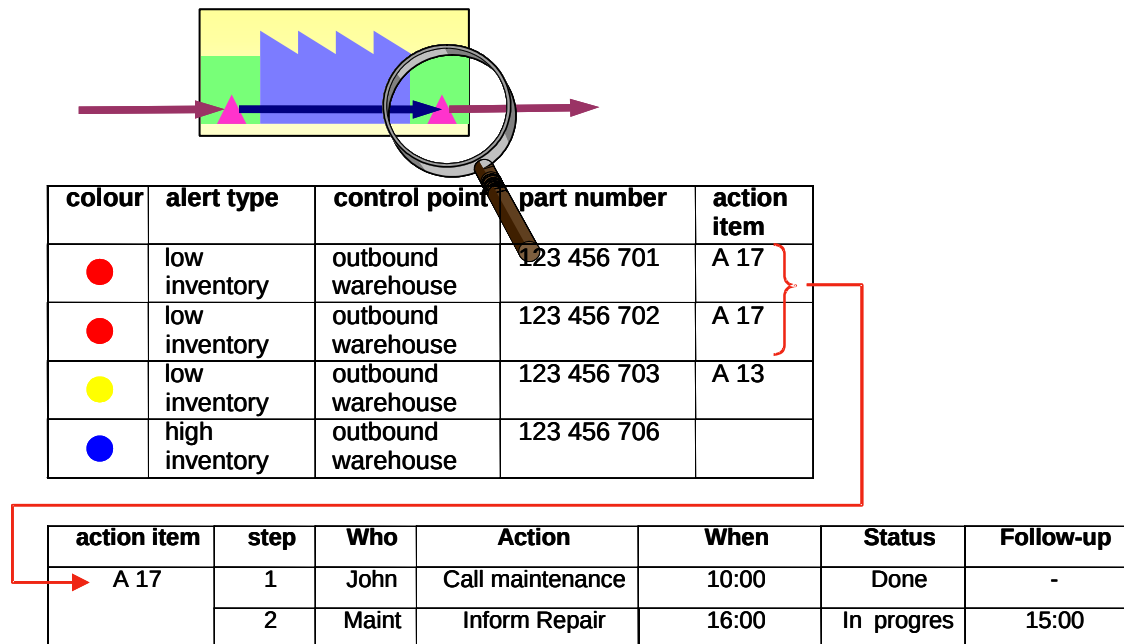


Table 1: Alert Generation, Alert Board, and Action Item Board

Filtering, sorting, and grouping alerts assist the end user to prioritize and manage corrective action. The filtering and sorting criteria may include priority, alert type, alert color, or user. Grouping criteria could involve finding a common root cause for several alerts (e.g., machine breakdown affecting several part numbers). Action items can consist of several steps that can be assigned to different persons for resolution.

In addition, alerts must be generated and distributed to predefined user group(s). Some companies may choose to show who is to be informed and when for each alert type and location using an alert definition

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board as shown in Table 2. The board also records the agreed reaction time for resolution and how the issue is to be escalated in the event of a failure as shown in Table 3.

Organizational Unit: Stamp & Die Inc., Plant XYZ

Central Administrator: Mr. Black

alert type	control point	part number / family	alert colour	alert threshold	alert owner name	Maximal reaction time (mrt)	...
inventory on hand	inbound warehouse. 3	137 387 \$\$\$	red	1,5 DOS	Mr. Miller	2 hours	...
			yellow	2,5 DOS	Mr. Miller	6 hours	...
			blue	10,0 DOS	Mr. Miller	24 hours	...
inventory on hand	outbound warehouse B	076 587 6\$\$	red	...	...	...	...
no inventory update	inbound warehouse 3	137 387 \$\$\$	red	1,5 days	If the alert owner does not react within the specified time limit, the next person according to escalation scenario will be notified (e.g. via email)		
no inventory update	outbound warehouse B	076 587 6\$\$	red	1,5 days			
...	...	...	...	...			

DOS = days of stock, \$ = wildcard

Table 2: Contacts to Receive Alerts

Organizational Unit: Stamp & Die Inc., Plant xyz

Central Administrator: Mr. Black

part number / family	alert colour	...	escalation step 1 name	mrt	escalation step 2 name	mrt	additional alert sub- scription	information time lag (itl)
137 387 \$\$\$	red	...	Mr. Blue	4 h	Mrs Jones	6 h	g.bush@usa_corp.com	6 h
	yellow	...		12 h		24 h	a.hill@down_ltd.com	12 h
	blue	...		48 h		60 h	g.bush@usa_corp.com	12 h
076 587 6\$\$	red	...	...	...	...	...	a.hill@down_ltd.com	24 h
137 387 \$\$\$	red	...	...	...	Additional persons in- and outside the organization might be interested to be informed about exception situations		In general, subscribers are not interested in alerts that can be solved quickly	
076 587 6\$\$	red	...	...	...				
...	...	...	...	...	...	...	...	...

\$ = wildcard, mrt = maximal reaction time

Table 3: Reaction Time for Resolution

3.5.4 Alert Archiving

Archiving is necessary and important for supplier ratings and for reconciling discrepancies. Both customer and supplier should be able to historically reflect, at a minimum, the occurrence of standard alert situations (see section 3.5.1 for standard alerts). The time period of archiving as well as the data elements associated with alerts must be mutually agreed by the customer and supplier. This agreement should be communicated to the application provider.

3.6 Supplier Performance Evaluation

This section describes how to measure the delivery performance of a Min/Max supplier. This section is not intended to cover all supplier performance aspects of the Global Materials Management Operations Guideline/Logistics Evaluation (MMOG/LE).

Performance evaluation is critical with any process but is even more critical with Min/Max replenishment. With Min/Max, suppliers are required to react much faster than with a typical push-based process. Therefore, measuring a supplier's performance is critical to identify problems quickly before there is an effect on the operations of a plant or warehouse. Using a performance measurement that is in place for another replenishment method will not work. Since there is not an exact quantity required for shipment and suppliers do not ship to forecasted releases, a performance measurement that takes these items into consideration must be in place.

With a push-based process, the measurement is based on whether a release, or order, quantity is receipted on the date requested by the customer. This does not necessarily reflect whether the customer needed the part but rather complies with the date and quantity sent by the customer to the supplier. With Min/Max and other pull-based systems, the requirement from the customer is based on actual usage. Therefore, failure of the supplier to comply could directly affect production at the customer. Since Min/Max tools are designed to alert when a critical limit is reached, a performance measurement system based on this critical limit is essential.

The events, and the method of measuring those events, are up to each company. Performance ratings can be created for both suppliers and customers in the process. Performance measurements should not be set up for events that are not part of the process or that cannot be measured. Suppliers should have as much visibility of the measurements as the customer. The measurements used should be clearly communicated to both suppliers and internal users along with expectations of service levels.

3.6.1 General

Key Performance Indicators (KPI)

The partners should define objectives and KPIs including the method of measurement and monitoring. The following are common KPIs that most likely exist before implementing CMI Min/Max:

- Average days inventory on hand
- Demand forecast quality
- Quality of packaging and shipping documentation

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- Difference between ASN quantity and quantity received
 - o Accuracy of the DESADV/ASN (i.e., incorrect shipping identification or no ASN/DESADV created).

For the Min/Max process, an additional KPI has to be introduced:

- Compliance to the Min/Max levels.

3.6.2 Service Level Measurement

The preferred method for measuring compliance to Min/Max service levels is called the Black and White method.

Black and White Measurement

The supplier is responsible for ensuring that the customer stock is always between the defined min and max range during the time period negotiated between the customer and supplier.

- If he succeeds, his service level is 100percent.
- If he doesn't succeed, i.e., the stock is under the minimum or over maximum, his service level is 0 percent.
- The customer may choose to define a grace period where it is acceptable to temporarily go above the maximum or below the minimum.

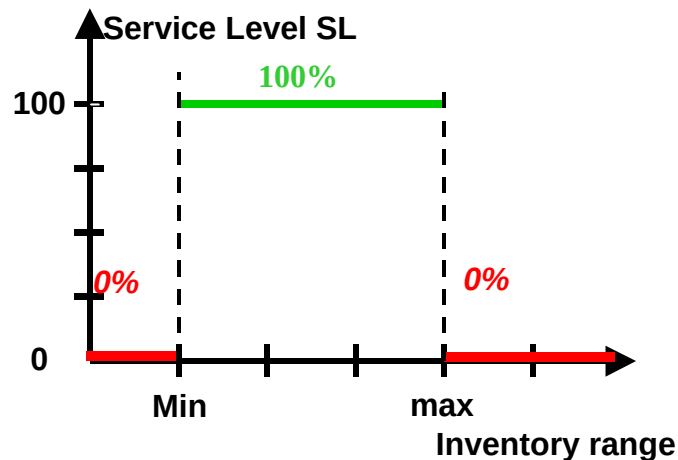


Figure 19: Black and White Measurement

An alternative method for measuring compliance is the weighted under- and over-delivery method. This method is explained in Appendix B.

4.0 CMI MIN/MAX AGREEMENTS

The CMI Min/Max agreements or logistics agreements usually are part of purchasing contracts between customer and supplier. The following list is a recommendation of key components as described in previous sections:

- Business processes affected by CMI Min/Max include when to ship, what logistics to use, and when to expedite, etc.
- Key Performance Indicators (KPIs), especially CMI Min/Max supplier rating.
- Management of alerts.
- Flexibility (capacity) agreements and fabrication and raw material authorizations between customer and supplier must reflect any changes involved with CMI Min/Max.
- Data accuracy levels that each partner is responsible for must be mutually defined (e.g., Min/Max levels, inventories, etc.). Data quality is a key requirement for a successful CMI Min/Max process. For this reason, sensibility checks and rigorous detection and elimination of the root causes of false alerts are fundamental and must be established in the work procedures.
- Contractual terms regarding the conditions of warranty, liability, and insurance.

5.0 DATA DESCRIPTION

While detailed data modeling has not yet been undertaken by the global CMI Min/Max group, the following list provides an overview of the data associated with CMI Min/Max. CMI Min/Max deals with three categories of data: company-internal data flow, data flow between customer and supplier, and CMI Min/Max level internal data.

Company-internal data flow. Individual company integration concepts are required for the information flow between the backend system(s) and the respective CMI Min/Max instance.

In addition to standard information such as Supplier Part Number, Customer Part Number, and Unit of Measure, CMI Min/Max-specific data sets are the following:

- In-transit and planned shipments
- Inventory information
- Planned (gross demand) and actual consumption
- Receiving information

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- Min/max levels

Data flow between customer and supplier CMI Min/Max instance. This information flow between the CMI Min/Max instances is key to interoperability.

Basic data sets are these:

- In-transit and planned shipments
- Inventory information
- Planned (gross demand) and actual consumption
- Receiving information
- Min/Max levels
- Alert communication
- General information (e.g., partner identification)

CMI Min/Max level internal data are stored and updated in the CMI Min/Max instance of each company. Typically these are data for the following:

- Administration and user rights
- Master data that is needed for the CMI Min/Max process but not available on an ERP level
- Transportation link parameters

6.0 IMPLEMENTATION CHECK LIST

The following checklist should be reviewed before beginning implementation of CMI Min/Max.6.1 Preliminary **Analysis Business Process – Planning Customer Decision Process for Using Min/Max**

In the following section are questions that must be answered before implementing a Min/Max replenishment system. The items below do not dictate what to do, but the answers to the questions will lead to the optimal use of the tool in CMI Min/Max level in your company.

A decision process must be in place to determine if your company should use Min/Max and, if so, for which parts. The Application Matrix (see Appendix A) can be used for this purpose. There are varied answers as to what is the “perfect” part for Min/Max. Much depends on the requirements of your company and what the end goals are for using Min/Max. Listed below are some of the prerequisite questions to using Min/Max replenishment.

- **Is there a consistent part flow?**
 - If there is sporadic demand or intermittent requirements, Min/Max may not be the best method for managing replenishment.
- **Is there a system to feed data to the Min/Max tool?**
 - Min/Max systems work only with a steady and consistent flow of data.
- **Is there a need to communicate faster and electronically with your suppliers?**
 - Min/Max replenishment with online tools will satisfy OEM requirements for electronic communication and speed data to suppliers.
- **Is there a business case and funding?**
 - Since Min/Max is usually implemented on a site-by-site basis within a company, there must be a justification for the funding and funds available.
- **Is there willingness on your company's part to trust, share, and give up some control in your company's replenishment process?**
 - Implementing Min/Max requires that the customer give to the supplier some control that has typically been with the customer. Suppliers will be allowed much more data than they have typically been given.
- **Is your company willing to change its business processes for replenishment?**
 - Min/Max is a major change to many companies' replenishment processes. There must be a willingness to reengineer these processes.
- **Is your company willing to review internal material management processes?**
 - Min/Max quickly shows inventory changes and transactions. It is very important that the internal materials management processes are reviewed to ensure that data inventory is kept accurate. When using Min/Max, there should be additional eyes reviewing the data.
- **Is your top level management willing to support Min/Max?**
 - Without the support of upper management, a Min/Max project can quickly become a failure. Implementation requires the support of many areas within the organization. Because of the amount of support required and the changes involved in internal (and external) business processes, upper level support is mandatory.

How your company answers these questions will indicate if Min/Max should be considered. When changing to a pull-based system like Min/Max, many of the business processes that are currently in place must change.

1) Analyzing Your Parts

Once the decision is made to use Min/Max, part characteristics must be reviewed. Some parts may fit into the replenishment strategy, and some may be better suited for other replenishment methods.

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a) Characteristics to consider for each part or supplier:

- o Supplier's distance from the plant or warehouse
- o Part lead time
- o Shipment frequency
- o Part shelf life
- o Part criticality to production
- o Forecast stability
- o Part complexity
- o Part uniqueness
- o Part cost
- o Part size
- o Variable lot quantity
- o Parts requiring special handling (hazardous materials, quality issues, etc.)

After these characteristics are reviewed, a strategy should be formed. For example, your company may want to start with all high-cost, short-distance, and low-complexity parts first and not include parts that are more than five days in-transit. Since no two companies are alike, the strategy for using Min/Max will differ among companies. Variable lot size parts are ideal for Min/Max replenishment. Since it is almost impossible for the suppliers of these parts to hit an exact quantity, traditional measurement systems penalize these suppliers. The strategy your company chooses can change over time based on the overall materials management goals that are set. Remember: there are other pull and push strategies that may be more appropriate for some parts.

b) From the customer side, the following processes need to be reviewed before starting Min/Max:

i) Forecast data accuracy

Without accurate forecasting, suppliers will see differences between the number they produce and the number your company requests for shipment.

ii) Level of inventory accuracy

A high level of inventory accuracy is a must. The saying "garbage in, garbage out" will be very apparent to both you and your suppliers if the data elements are not correct.

iii) Container/Lot quantity

Suppliers are asked to ship based on an upper and lower limit. If the case pack size is too large, it will be very difficult for the supplier to stay within the limits set, or it will increase the customer's inventory.

iv) Inventory data update frequency

With CMI Min/Max levels (e.g., inventory visibility tool), reaction times are greatly reduced. For decisions to be accurate in this type of environment, data must be refreshed on a consistent basis as the demands are placed on your suppliers. If data elements are refreshed only once per day, then your supplier will only be given a "view" into your system once a day. The more often data elements are refreshed, the more accurate are the "views" your supplier gets into your system.

Note that the business process changes made with Min/Max will have an equal effect on both the customer and the supplier. Input on these changes from both sides is highly recommended.

2) Evaluating Your Supplier's Min/Max Capabilities

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When reviewing which suppliers to add to a Min/Max replenishment process, three main areas should be considered:

a) How receptive will the supplier be to change and how accepting of new processes?

Suppliers that are “set in their ways” may need education on the business process changes that will occur with Min/Max replenishment. This can help speed up the implementation process and quickly clear up misunderstandings.

b) Which suppliers are EDI-capable?

Suppliers that are currently using EDI with a customer may not see the need for Min/Max replenishment. They may also be concerned that the process will become less automatic. This should be discussed with EDI suppliers before the implementation. Two key items to review are that EDI can still be used (complementary to CMI Min/Max level or tool) and that Min/Max includes exception-based management.

c) What is the supplier’s performance (good/bad)?

With Min/Max replenishment, added trust and additional responsibility are given to suppliers. This does not mean that only “good” suppliers should be used with Min/Max. Since Min/Max tools have exception-based alerting, monitoring marginal suppliers becomes much more proactive. Both good and marginal suppliers are equally suited for Min/Max. With marginal suppliers, using Min/Max replenishment may actually improve their performance.

3) Communicating the Min/Max Processes

Clearly the most important element in a successful Min/Max implementation is to communicate the business processes both internally and externally. While Min/Max may seem simple in execution, there are many items that need to be defined and clearly communicated. Failure to address this part of the implementation will reduce or eliminate any gains your company achieves.

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a) Within the customer's locations the following items need to be identified and in place:

i) Consistent business process rules across all locations

Asking suppliers to service customer plants differently from the same location can cause additional work and confusion to the supplier. Also, materials management processes should be similar between locations or else identified before the Min/Max process is implemented.

ii) A clear definition of what the customer "On-Hand" inventory figure includes the following:

- (1) In-transit
- (2) WIP
- (3) Inspection (conforming/non-conforming)
- (4) Off-site (warehouse, storage trailer, sub-process supplier)
- (5) Raw
- (6) Returnable

iii) Material handling of non-conforming parts

Handling non-conforming parts quickly and accurately within the customer's systems is important. Since suppliers have a view into the customer's inventory systems, there must be a consistent and timely process to handle these parts.

The definition of which inventory to include can vary by customer location. Systems should be reviewed before implementation to ensure that each location can show the correct inventory.

b) Communicating your company's expectations and policies to the supply base is critical for a successful implementation of Min/Max. Since this might be a new process for both your company and the supplier, the following items need to be taken into consideration:

i) Supplier contact information

Since alerts are critical to the use of Min/Max replenishment, accurate contact information must be maintained.

ii) Which side will be responsible for costs/savings

With Min/Max replenishment, costs and savings will likely occur. Outline with the supplier ahead of time who is responsible for the costs and who benefits from the savings. The main areas where there could be significant costs or savings are these:

- (1) Increases/decreases in shipment frequencies
- (2) Premium freight instances
- (3) Line shutdowns or scheduling changes
- (4) Excess inventory at both the supplier and the customer
- (5) Cost of using the Min/Max tool
- (6) Training
- (7) Staff additions or reductions due to the Min/Max process

iii) Performance requirements and expectations

How suppliers will be measured and what service levels will be expected must be defined. Since Min/Max is a change to the replenishment business process, performance measurements with traditional push systems will not work.

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iv) Terms and conditions of contracts

Does the use of a Min/Max tool require a change to the terms and conditions of current contracts?

v) Logistics requirements

- (1) Returnables (use and replenish)
- (2) Ship frequency
- (3) Change in carrier
- (4) Collection routes and milk runs
- (5) Customer and supplier window times

vi) Calculating Min/Max quantities

How the limits are set along with the calculations that derive them should be clearly communicated to suppliers. Having the supplier do a “reality check” is essential.

vii) Weekend/Holiday/Shutdown ship schedules

Suppliers must be given clear instructions on how to handle exceptions to the plant’s normal schedule.

viii) ASN requirements, timing, and adherence

Suppliers should be made aware if there are window times for ASN entry and how that could affect their performance rating. Since this process may be new to many of the non-EDI suppliers, clear instructions should be given.

ix) Ship quantity

The supplier should know exactly what to ship and when. This may seem simple, but with Min/Max there can be different strategies on when the supplier ships and how much. With a pull-based system, this is much easier for the supplier to understand. With Min/Max, there is a lot more flexibility and uncertainty on the supplier side.

Many of these items may appear to be clear on the customer side, but they may be misunderstood by suppliers if they are not clearly explained. With Min/Max replenishment, there are different requirements placed on the supplier versus traditional push-based replenishment. Unless clear policies have been created, with input from suppliers, problems will occur very quickly.

6.2 Before Going Live with CMI Min/Max

At an early stage, both the customer and the supplier should check national regulations and the effects of implementing CMI Min/Max, especially with regard to taxes and custom duties.

Similarly, there is a list of issues that must be agreed by both partners before going live with CMI Min/Max.

6.2.1 Competence / Position of the Customer’s Materials Requirement Planners

During parallel processing (appropriate period, e.g., 1 week):

- Maintain the agreed min/max levels in the ERP system, if possible; otherwise, maintain them directly in the CMI Min/Max level.
- Verify that the stock shown to your suppliers is accurate.
- Introduce transit time from the supplier to the plant. Depending on the terms of delivery, this may be the task of the supplier.

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- Verify that all the relevant part numbers for Min/Max are set up in the tool.
- Identify the method of alerts for each contact: email (recommended), online notifications, or fax.
- Make sure the supplier provides the planned shipment information (if required for transport planning) and ASNs properly.
- Ensure proper processing of delivery notes in goods received so that the ASNs in transit are automatically removed once they have arrived.
- Verify the supplier's fabrication authorization days and ensure that they are properly processed at the CMI Min/Max level.
- On the last day of parallel processing, change the ERP settings to show gross demand to the supplier.

6.2.2 Competence / Position of the Suppliers

During parallel processing:

- Verify that all the part numbers are set up on the CMI Min/Max level, including description, packing unit, etc. The supplier should look for missing or unknown parts and contact the customer with any discrepancies.
- Inform and discuss with the supplier any concerns with the Minimum and Maximum levels.
- Check the different modes of transport proposed by the customer in order to agree on the most effective transit solution. Depending on the terms of delivery, this may be the task of the customer.
- Test synchronization of inventory and demand information and ASN (in conjunction with the customer).
- Check the last ASN/delivery notice advised to the customer.
- Introduce material in transit (i.e., ASNs that have already left the plant but not arrived at the customer either manually or via EDI).
- Set up the appropriate alert medium: email (recommended), online notifications, or fax, in order to receive automated alerts, e.g., for an inventory level dropping below minimum.

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6.3 After Going Live with CMI Min/Max

6.3.1 Competence / Position of the Customer's Materials Requirement Planners

General principle

- Do not manually modify the quantities and dates in the forecast schedule. If you do so, the supplier will not consider the quantities in the schedule as shipping orders but as production consumption information.

Random tasks considering that an automatic link is provided from Enterprise Resource Planning (ERP) to CMI Min/Max level

- Verify that the planned shipments have been provided (if required for transport planning).
- Verify that the ASNs have been provided correctly.

Regular tasks

- Whenever an automated CMI Min/Max Alert is received, check the situation carefully and initiate appropriate corrective action.
- Review Min/Max levels every month at a minimum (frequency depends on the complexity of the plant); send an advice to the supplier if any change is made.

Phase-out of a product

- Recalculate the Min/Max level more frequently and send an advice to the supplier after each Min/Max adjustment.
- Verify the product life cycle demand.
- Put a note into the comments field saying that the part is phased out and the Min/Max levels may fluctuate more frequently.

Ramp-up / Launches

- Prior to material release, sample parts must be ordered via spot buys.
- Once a blanket purchase order (PO) is issued, the part must be visible in the CMI Min/Max level.
- Consider the supplier's lead-time when establishing PO quantity and date required.
- Recalculate the Min/Max level more frequently and send an advice to the supplier after each Min/Max adjustment.
- Send an alert notifying the supplier to view the forecast for launch requirements.

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- Put a note into the comment fields saying that the part is in a ramp-up phase and the Min/Max levels may fluctuate more frequently.

6.3.2 Competence / Position of the Suppliers

Regular tasks

- Keep the customer's inventory levels in the green.
- Produce parts based on the forecast / fabrication authorization.
- Provide planned shipment information. Give shipping instructions to the warehouse or shipping department, taking into account the situation of the CMI Min/Max level. Introduce the planned shipment in the system for the material available. The quantity to send to the customer in every shipment should be decided by the supplier according to the Min/Max levels. A "Suggested delivery" should help the supplier to know how much should be shipped.
- Provide accurate shipment information (ASNs).
- Whenever an automated CMI Min/Max Alert is received, check the situation carefully and take appropriate corrective action.

6.3.3 Process Monitoring

After implementation, the following reviews should be undertaken with respect to monitoring the effectiveness of the CMI Min/Max process:

- What KPIs should be introduced, in addition to the delivery rating (see section 3.6), and by whom, when, and how often they must be monitored.
- How the monitoring results must be communicated between the two partners.
- Check the accuracy of the calculation methods.

NOTE: CMI Min/Max replenishment is not a process that runs automatically. By using alerts and exception-based management, Min/Max tools do help reduce the reactive side of material replenishment. However, there are potential pitfalls with a Min/Max implementation that should be taken into consideration:

- Lack of maintenance on Min/Max levels will cause inventories to rise or fall below acceptable levels. The data given to suppliers will be conflicting. Ship quantities will be higher or lower than the forecasted quantities. Either way, costs are increased.
- Performance measurements must be reviewed on a regular basis. Without regular reviews of the supplier's performance, improvements and corrections cannot be made.
- Costs in other processes must be reviewed on a regular basis. Min/Max replenishment changes can affect other areas. Good examples of this are freight, administrative, and

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piece costs. Any increase in these costs due to the use of Min/Max must be viewed as an offset to the savings from Min/Max.

7.0 FUTURE RELATED SUPPLY CHAIN INITIATIVES

The following are supply chain-related initiatives that should be considered after implementing CMI Min/Max:

- Once CMI Min/Max is established between supply chain partners, there is a pull-based methodology in place that is based on replenishment by quantities. This allows a switch to other pull-based replenishment methodologies such as Kanban. The switch must be verified on cost effectiveness and adequacy in the specific situation.
- The link from CMI Min/Max to future transport concepts (e.g., milk runs, pickup, etc.) will contribute to further logistics cost reductions.
- Advanced Auto ID processes (e.g., RFID) can reduce manual error during the supplier's dispatch process, improve inventory accuracy, and reduce the time required to receive parts.
- With visibility greatly increased for incoming parts, tracking returnable containers could also be added to the items monitored.

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APPENDIX A APPLICATION MATRIX FOR CMI MIN/MAX

The Application Matrix in Table 4 should be used to assist in deciding whether introducing a CMI Min/Max process is feasible and practical.

Table 4: Application Matrix for CMI Min/Max

Application areas for CMI Min/Max *

Criterion	Characteristic			
1. Products				
1.1 Product Complexity	products with single stage production process	products with multi-stage production process	complex products (systems) with multi-stage structure	
1.2 Priority (\$-Volume)	A-products	B-products	C-products	
1.3 Standardization	standard products without variants	standard products with variants	customer specific products based on standard modules	highly individual customer specific products
1.4 Reliability of Supply	low	medium	high	
1.5 Character of Production	non-repetitive production (one-time)	small-lot production	series production	70
1.6 Class of Demand	indirect material	direct material	spare parts	
1.7 Replenishment Lead-time	short	medium	long	
1.8 Sourcing	single sourcing	dual sourcing	multi-sourcing	
1.9 Phase of Life	ramp-up	stable	phase-out	
1.10 Frequency of engineering changes	low	medium	high	
1.11 Sensibility regard. Quality	low	medium	high	
1.12 Demand Pattern	steady	seasonal fluctuation	sporadic fluctuation	cyclic (ongoing change between shortage and overcapacity situation)
2. Processes				
2.1 Production Strategy	built to stock	configure to order	built / assemble to order	design to order
2.2 Investment in Production Facilities	invest for production facilities rather low	medium invest for production facilities	invest for production facilities rather high	
2.3 Manufacturing Type	process manufacturing	discrete manufacturing		

Relevance for CMI Min/Max

high
 medium
 low
 no relevance

On the basis of different checkpoints, the matrix shows which characteristics are most relevant in a CMI Min/Max process.

When implementing CMI Min/Max with suppliers, you must select which partners to work with and in which order. Different suppliers will offer different paybacks as well as challenges. Each company must consider its strategic objectives in prioritizing the implementation process.

The content of the Application Matrix should be used as guidelines. The relevance stated in the matrix reflects the opinion of the work group. If necessary, the user should add and amend checkpoints and characteristics to reflect the specific nature of his business or relationships.

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APPENDIX B WEIGHTED UNDER- AND OVER-DELIVERY AREAS

Steps for calculating the Service Level:

- Calculate the Under/Over Delivery Areas
- Consider the Weighting Factors
- Calculate the Cumulative Under/Over Delivery Area
- Calculate the Weighted Figure G
- Select the Tolerance Category
- Calculate the Service Level
- Calculate the Under/Over Delivery Areas

The following is an excerpt from the VDA 5001 Logistics Supplier Assessment. A translated version of the VDA 5001 recommendation can be found on the AIAG web site.

Multiply the under-min or the over-max stock quantity with the deviation time:

- Under-Delivery Area:  $25 * 2 = 50$ [pieces*days]
- Over-Delivery Area:  $25 * 1 = 25$ [pieces*days]

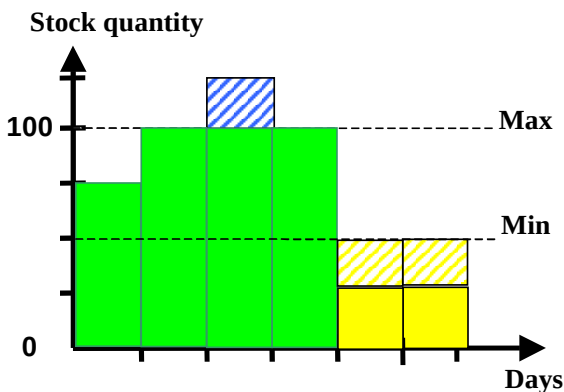


Figure20: Weighted Under- and Over-Delivery Areas

- Weighting factor
- Under-delivery = 2, Over-delivery = 1
- Calculate the cumulative and weighted Under/Over Delivery Area

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- $50 * 2 + 25 * 1 = 125 \text{ pieces*days}$
- Calculate the Weighted Figure G

This cumulative under/over delivery area is now related to the cumulative gross demands during the period under consideration (6 days):

“Weighted Figure G”: $G = 125 \text{ pieces*days} / \text{xyz pieces} = \text{abc days}$

Calculation Example

- Select the Tolerance Category

The tolerance categories reflect the relative importance of the parts being considered. A part requiring the highest service level is rated Category “A.”. In contrast, a part requiring the lowest service level is rated Category “C.”. The "upper tolerance limit" is the delivery deviation acceptable for a service level of 100 percent. The "lower tolerance limit" is the delivery deviation below which will result in a service level of 0 percent. The tolerance limits for the three tolerance categories are shown in Table 5.

		Category		
Tolerance Limit		A [days]	B [days]	C [days]
upper tolerance limit “a”	≤	1	2	5
lower tolerance limit “b”	≥	4	6	10

Table 5: List of Tolerance Limits

Delivery Schedule System

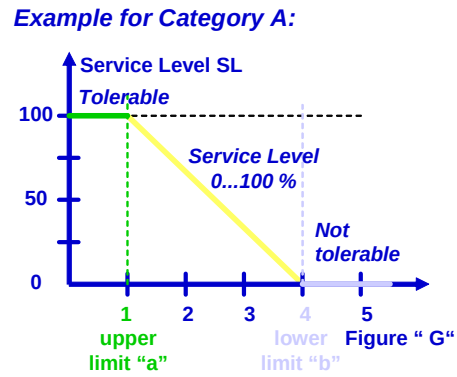


Figure 21: Example for Category A

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Calculation Example

- Calculate the Service Level

Based on the calculated “Weighted Figure G” and considering the tolerance limits, the service level can now be calculated according to the following formula, which will produce the graph shown on the previous chart:

$$SL = \frac{G - a}{b - a} \max \{0; 100 - 100 * \max (0; \quad)\} \text{ in } \%$$

This formula shows that the service level cannot become negative, and stays within the range between 0→100 percent. For the example shown, the service levels of the three tolerance categories are the following:

G = 4.67 days:

- Category A: $SL = \max \{0; 100 - 100 * \max [0; (4,67 - 1) / (4 - 1)]\} = 0 \%$
- Category B: $SL = \max \{0; 100 - 100 * \max [0; (4,67 - 2) / (6 - 2)]\} = 33 \%$
- Category C: $SL = \max \{0; 100 - 100 * \max [0; (4,67 - 5) / (10 - 5)]\} = 100 \%$



→ The service level depends very much on the tolerance category.

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GLOSSARY OF TERMS AND ABBREVIATIONS

<i>3PL</i>	Third Party Logistics
<i>ADU</i>	Average Planned Daily Usage
<i>ASN</i>	Advanced Shipping Notice
<i>BOM</i>	Bill of Material
<i>CMI Min/Max</i>	Collaboration Managed Inventory with a fulfillment methodology using agreed minimum and maximum inventory levels.
<i>DELFOR</i>	Delivery schedule message used in EDI
<i>DUNS</i>	Data Universal Numbering System
<i>EAI</i>	Enterprise Application Integration Information Flow
<i>EDI</i>	Electronic Data Interchange
<i>ERP</i>	Enterprise Resource Planning
<i>EXW</i>	Ex Works
<i>Incoterms</i>	ICC introduced the first version of Incoterms - short for "International Commercial Terms" - in 1936. Incoterms are standard trade definitions most commonly used in international sales contracts. Devised and published by the International Chamber of Commerce, they are at the heart of world trade. Among the best known Incoterms are EXW (Ex works), FOB (Free on Board), CIF (Cost, Insurance and Freight), DDU (Delivered Duty Unpaid), and CPT (Carriage Paid To). For more information on Incoterms visit http://www.iccwbo.org/index_incoterms.asp .
<i>JIS</i>	Just-In-Sequence
<i>KPI</i>	Key Performance Indicator
<i>Qty</i>	Quantity
<i>SCIP</i>	Supply Chain Interoperability Protocol
<i>SCM</i>	Supply Chain Management
<i>ScMo</i>	Supply Chain Monitoring
<i>SL</i>	Service Level
<i>VDA</i>	German Association of the Automotive Industry
<i>XML</i>	Extensible Mark-up Language
<i>Warehouse</i>	For the purposes of this document, "warehouse" refers to any stock location that exists in the supply chain (i.e., physical building or any other location with stock).

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