aPriori

MANUFACTURING AND MATERIAL COST DATA FOR STRATEGIC PRODUCTION DECISIONS

aPriori Regional Data Libraries

This document describes Regional Data Libraries, identifies their data sources, and explains the methodologies behind the data.

Introduction

Changing material prices, rising labor costs, and trade conflicts make it difficult to compare manufacturing costs across regions.

aPriori Regional Data Libraries (RDLs) give access to timely data on material and supplier production costs across **93 regions worldwide**. The data covers material prices, regional labor rates, and manufacturing overhead (direct and indirect overhead expenses, tool shop rates, etc.). Manufacturers use it to benchmark production cost estimates, compare sourcing options, and address supply chain risk.

Use Global Manufacturing Data to Make Decisions Quickly and Confidently

The aPriori RDL is a database of economic manufacturing data gathered from multiple regions representing standard production processes and costs in each location. Companies integrate RDLs into their **digital factories** to analyze "build vs. buy" options, determine how relocating manufacturing will affect costs, and create detailed estimates.

Manufacturers also use RDL data for multiple cost benchmark applications, including:

- Support fact-based supplier negotiations with detailed manufacturing and economic data across more than 90 regions
- Benchmark supplier quotes against regional direct and indirect costs
- Assess the cost and sustainability impact of sourcing components in different regions by evaluating multiple locations simultaneously
- Develop early budgetary estimates to improve target cost accuracy
- Estimate the fastest and most cost-effective engineering change orders (ECOs) and design alternatives

The Breadth and Depth of aPriori's Regional Data Library

Labor Rates

Each rate is fully burdened and includes direct wages, directly paid benefits, and social overheads. aPriori reports rates in USD, so they can shift between releases as exchange rates move.

Overhead Rates

Overhead rates cover each machine in each region and include direct and indirect overhead costs.

Tool Shop and Machine Rates

These rates cover specific tool shop operations and the machines used in manufacturing.

Material Rates

- **Material overhead and SG&A rates:** overhead costs associated with materials and selling, general, and administrative (SG&A) expenses.
- **Material pricing data:** prices cover four material regions: North America, Asia, Europe, and world average. They update four times a year.
- **Material physical properties and stock sizes:** the library includes about 700 material compositions, 14 stock forms, and hundreds of stock sizes.

Interpath, aPriori's data partner, provides prices for metals and plastics. It mainly uses London Metal Exchange data and benchmarks against sources such as Fastmarkets, MEPS, and Trading Economics.

What Are the Currently Supported Regions?

aPriori offers multiple RDLs for major manufacturing markets, including China, the U.S., India, and Mexico. This helps manufacturers compare production costs when evaluating where to source components or manufacture products. **See the economic updates.**

The following chart shows the currently supported regions in aPriori Regional Data Libraries. View labor and total manufacturing rates by region on the interactive map.

EMEA			APAC		AMERICAS	
Eastern Europe	**Morocco**	**Russia**	**China**	**Australia**	**Brazil**	**Argentina**
Western Europe	**Netherlands**	• City of Moscow	• Beijing	**India**	• Rio Grande do Sul	**Canada**
Austria	**Norway**	• Tyumen	• Chengdu	• Maharashtra	• São Paulo	• Atlantic (PE-NB-NL-NS)
Belgium	**Poland**	• Saint Petersburg	• Chongqing	• Delhi	• Rio de Janeiro	• West (BC-MB-SK)
Czech Republic	**Portugal**	• Moscow region	• Dalian	• West Bengal	**Mexico**	• Ontario
Denmark	**Romania**	• Sverdlovsk	• Guangzhou	• Karnataka	• Mexico City	• Quebec
Finland	**Slovakia**	• Leningrad	• Hangzhou	**Indonesia**	• North	• Alberta
France	**South Africa**	• Kaluga	• Qingdao	**Japan**	• South-west	**Chile**
Germany	**Spain**	• Udmurtia	• Shanghai	**Malaysia**	**United States**	
Hungary	**Sweden**	• Altaiskii Krai	• Suzhou	**Philippines**	• Northeast (MA-NY-NJ-CT)	
Ireland	**Switzerland**	• Republic of Dagestan	• Tianjin	**Saudi Arabia**	• Northeast-Rural (ME-NH-RI-VT)	
Israel	**Tunisia**		• Wuhan	**Singapore**	• Mid-Atlantic (DE-MD-PA-VA)	
Italy	**Türkiye**			**South Korea**	• North Central (IL-MI-MN-OH-WI)	
	United Kingdom			**Taiwan**	• Central (AR-IA-KS-MT-NE-ND-OK-SD)	
				Thailand	• Southeast (AL-FL-GA-IN-KY-LA-MO-MS-NC-SC-TN-WV)	
				Vietnam	• Mountain (AZ-CO-ID-NV-NM-UT-WY)	
					• Pacific (WA-OR-HI-AK)	
					• Texas	
					• California	

aPriori builds each RDL in U.S. dollars (USD) and converts data it gathers in foreign currencies to USD at the exchange rate when it generates the data. The total manufacturing rate comprises labor rates and overhead rates, which aPriori determines per machine. Both vary by region and include direct and indirect overhead costs.

"I have responsibility for three plants in different countries across the globe, and each plant is different. They have different cost structures and different cultures. But with the digital factory, we can easily configure our simulation to reflect these different manufacturing facilities."

Jegan Dhanapal, Senior Cost Leader, CNH Industrial

Sustainability Insights

With the 2023 R1 update, aPriori Regional Data Libraries expanded to provide sustainability insights. aPriori partners with **ecoinvent**, an international not-for-profit organization based in Zurich, Switzerland, that publishes and maintains a life cycle inventory (LCI) database for global sustainability assessments.

Using ecoinvent's LCI as a foundation, aPriori's Manufacturing Insights Platform calculates material carbon emission factors for each manufactured part. It also estimates electricity-related carbon emissions based on the part's manufacturing process. Both calculations rely on custom-selected manufacturing processes and routine logic.

Through manufacturing simulation, companies gain an understanding of the carbon emissions associated with the production process. With aPriori, companies can find and reduce the biggest carbon contributors early in the design stage.

Each ecoinvent dataset includes Life Cycle Impact Assessment (LCIA) scores for several impact assessment methods, such as IPCC 2021, and corresponding impact categories, such as climate change and global warming potential (GWP). Each activity in the ecoinvent database ties to a geographic location, which the dataset name shows with internationally accepted abbreviations.

FACTOR	MATERIAL CARBON EMISSIONS FACTORS	ELECTRICITY CARBON EMISSIONS FACTORS
Purpose	• Calculate the material CO_2e contribution for a part	• Calculate the process CO_2e contribution for a part
Process	• The carbon impact of the extraction and processing required to create the raw material used to manufacture the part • The carbon impact of additional processing steps to create the stock form required	• The energy usage from processes using electricity • The carbon impact of the electricity generated from the grid mix for a given country
Units	• kg CO_2e / kg of material	• kg CO_2e / kWh of electricity used
Location Mapping	• Europe • Rest of World	• Locations based on countries in aPriori's Regional Libraries



Regional Data

aPriori maintains much of the data in RDLs for each geographic region and maintains some data by continent or globally.

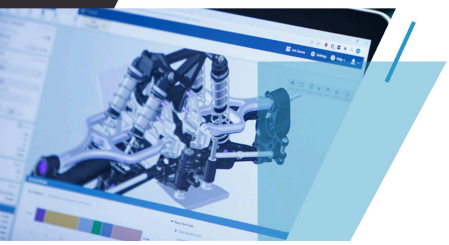
REGION LEVEL	DATA IN APRIORI REGIONAL DATA LIBRARIES
Each geographic region	Labor rates
	Direct and indirect overhead rates
	Tool shop rates
	Material overhead and SG&A rates
Material regions: North America, Asia, Europe, and world average	Material pricing data
Global, with no regional variation	Material physical properties and stock sizes
	Machines and machine properties

Machines

Each region has the same machine list with the same operating parameters (for example, power and table size). aPriori assumes the machines run at the same speed and feed in each region. Machine manufacturers' specifications and quoted prices serve as the primary source for machine capabilities and prices.

Data Partner

Interpath is aPriori's data partner. Kerkhoff, which aPriori has worked with for many years, is now part of Interpath. Interpath's benchmark database covers material pricing, labor and social costs, and energy and overhead costs across 800 regions worldwide.



Labor

aPriori labor rates represent a fully burdened labor rate that includes direct wages, directly paid benefits, and social overheads. aPriori computes each rate from three inputs:

Fully burdened labor rate = direct wage * direct benefits factor * social insurance factor

1. **Direct wage.** Interpath supplies the direct wage data. A direct wage is the pay an employee receives for manufacturing time worked, including basic wages, piece rate, and bonus paid each pay period.

The direct wage for each process depends on three attributes:

- **region:** the global location of the RDL
- **skill level:** the typical skill a machine operator needs to run the process in a non-automated manufacturing environment
- **industry:** the industry that matches the process group, as the table shows

INDUSTRY	PROCESS GROUPS	
Metal	• Assembly • Bar & tube fab • Composites • Forging • Heat treatment • Machining • Other secondary processes	• Part assembly • PCB • Powder metal • Rapid prototyping • Sheet metal • Stock machining • Surface treatment
Plastic	• Assembly plastic molding • Composites • PCB • Plastic molding	• Powder metal • Roto & blow molding • Sheet plastic
Casting	• Casting	
Electronics	• PCB fabrication • PCB assembly	• Wire harness

In addition to the world average, each RDL contains nine wage grades (1-9) for six industries: Aerospace, Automotive, Electronics, Heavy Industrial Machinery, Medical Devices, and Oil and Gas.

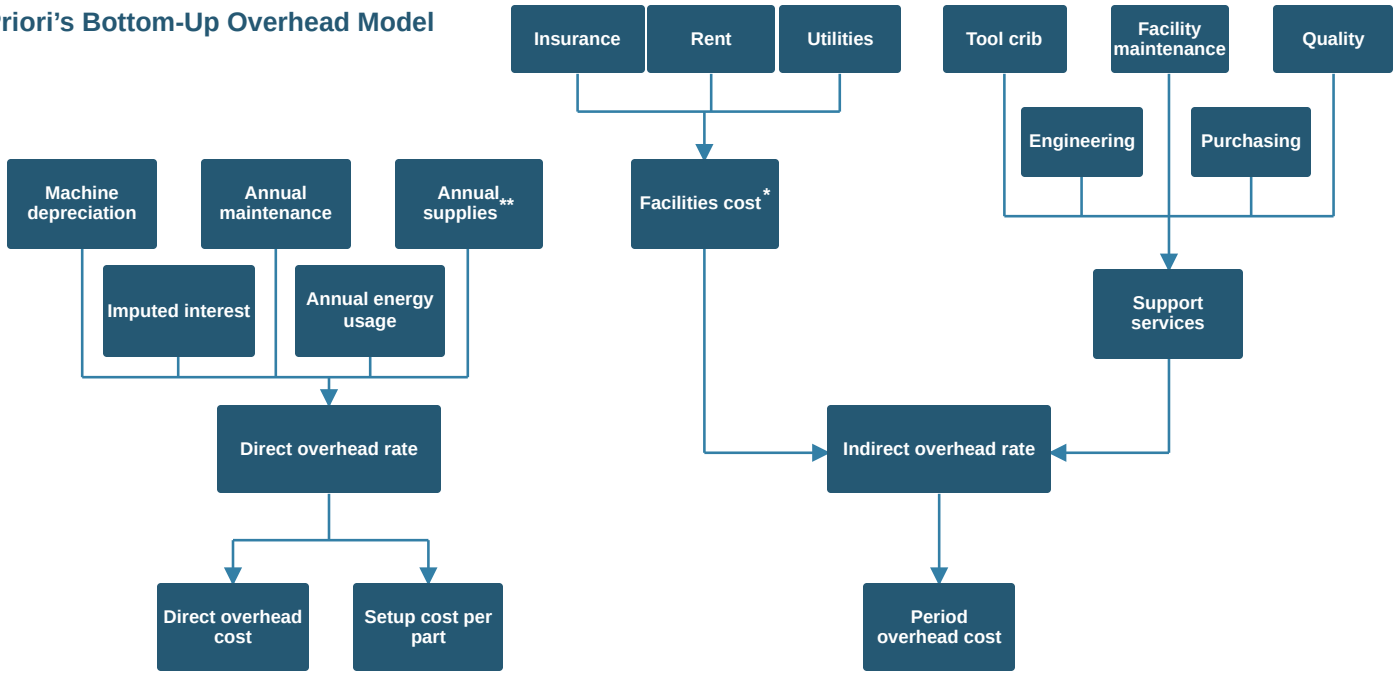
2. Direct benefits factor. This region-specific factor accounts for direct pay to employees for irregular activities, such as irregular bonuses, payments to employees' savings funds, payments in kind, and allowances for commuting, vacation, and holidays.

3. Social insurance factor. This region-specific factor accounts for social insurance expenses and labor-related taxes. Interpath supplies the factor. The factor includes pension, health, unemployment, and other insurance, such as accident insurance.

Overhead

aPriori determines a direct and indirect overhead hourly rate for each machine by region, following the methodology below. **The following chart shows the data sources that the overhead model uses.**

aPriori's Bottom-Up Overhead Model



**By default, aPriori accounts for facilities cost in indirect overhead. A digital-factory-level switch lets customers account for facilities cost in direct overhead instead.*
***By default, aPriori does not estimate annual supplies for a workcenter. Customers can populate this data in their digital factory.*

Overhead Inputs

The table shows the source, regionality, and update frequency for the main inputs to the overhead rates.

INPUT	SOURCE	REGIONALITY	UPDATE FREQUENCY
Electricity rate	Interpath	Regional	Annually
Imputed interest rate	World Bank	Regional	Annually
Purchasing power factor	World Bank	Regional	Annually
Rent rate	Interpath	Regional	Every few years
Engineering, purchasing, quality, tool crib, and maintenance rates	Interpath and aPriori	Regional	Annually

Direct Overhead

Each workcenter's direct overhead comprises machine depreciation + imputed interest + machine maintenance + energy to run the machine + annual supplies. aPriori calculates an annual workcenter budget from these factors and translates it into an hourly rate based on the annual earned machine hours for the workcenter.

Direct overhead rate = workcenter direct overhead / annual earned machine hours

Annual earned machine hours = capacity (number of shifts * hours per shift * work days per week * working weeks per year) * machine utilization (% of time machines run)

Capacity varies by region and accounts for each region's standard work week (for example, shifts per day and working days per week) and typical holiday and vacation allotment.

Machine depreciation. This cost includes the cost to buy the machine and the cost to install it. aPriori uses straight-line depreciation, assumes a $0 salvage value, and depreciates most machines over 10 years. aPriori obtains machine costs from a number of sources, most frequently the machine manufacturer or a reseller. In some cases, aPriori estimates a machine's cost by considering the cost of similar machines.

Imputed interest. Imputed interest is the assumed interest on the capital invested in the machine, even though no physical interest changes hands. aPriori uses a standard formula from the Fraunhofer Institute and RWTH Aachen University in Germany. **Annual imputed interest = (total machine cost + salvage value) / 2 * imputed interest rate.** The imputed interest rate comes from the World Bank.

Machine maintenance. The annual expense comes from industry research and ranges from 1.25% to 10% of machine cost, depending on the machine type. Most commonly, it equals 3% to 6% of a machine's cost per year.

Energy to run the machine. (Machine power * annual earned machine hours) * cost of energy.

Machine power. Machine power usually comes from the manufacturer's spec sheet. In some cases, aPriori estimates the power by analyzing the energy usage of similar machines.

Cost of energy. Interpath provides the regional electricity rate.

Annual supplies. aPriori's starting point cost models contain a variable for annual supplies, but aPriori does not populate it in the RDLs. The field supports companies that want to account explicitly for workcenter-specific supplies in direct overhead.



Indirect Overhead

Indirect overhead comprises a facility budget and a support services budget.

Facility budget. The facility budget accounts for the annual costs of the factory, including insurance and utilities (excluding the costs to run the machines). aPriori estimates the portion of the facility budget that applies to the workcenter based on the workcenter's square footage, and uses regional rent rates to estimate the cost of the facility.

Facility budget = annual rent + insurance + utilities

Annual rent = square footage of the workcenter * (1 + factor for non-production factory space) * annual cost per square foot

Square footage of the workcenter = machine length * machine width * allowance factor

Insurance = annual rent * (fire factor + loss factor + liability factor)

Utilities = annual rent * (electric factor + heat/gas factor + water factor)

Note: Each factor represents a % of annual rent.

Support services budget. aPriori models support staff as a fixed overhead. aPriori estimates support services for the workcenter by applying a fraction of each support service to it. For example, one quality worker covers 20 workcenters, so aPriori applies 5% of that worker's salary to a workcenter's indirect overhead.

Support services are the fully burdened salaries and expenses for the following groups:

- Engineering
- Maintenance
- Purchasing
- Quality
- Tool crib

Materials

The RDLs support commonly used material compositions for each manufacturing process group. aPriori maintains material physical properties and stock sizes globally, using materials databases.

Metal compositions use U.S. standard names and various international standards: DIN (German Institute for Standardization), EN (European Standard), JIS (Japanese Industrial Standards), and GB (Guobiao standards, China). Polymers use U.S. names and common European names.

Customers can refine material pricing further by selecting a purchase volume in tons. Purchasing larger tonnages drives cheaper material rates.

Material scrap % does not change with material price updates. It uses a preset value based on research that aPriori conducted with its cost model subject matter experts.

Regional Data Library Updates

aPriori updates RDLs four times a year. Updates apply to the current and previous major aPriori product releases. **Updates may contain:**

- Material rate updates
- New material compositions
- Labor rate updates
- Overhead rate updates, including updates to overhead rate inputs (electricity, rent, imputed interest rates, and more)
- Tool shop rate and price updates
- New machines

Each update contains release notes that summarize updates, enhancements, and bug fixes. **Customers can edit all data and assumptions in RDLs. Options include:**

1. Edit in a customer digital factory by using aPriori's overlay digital factory capabilities to combine aPriori and customer data.

2. Edit in a specific cost estimate scenario during cost refinement.

WANT TO LEARN MORE?

CLICK HERE to schedule a demo of the aPriori Manufacturing Insights Platform, the comprehensive manufacturing process simulation technology.

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