

Spares forecasting

A commercial aviation perspective on value chain maturity and best practices

*Understand best practices
and forthcoming next
practices to improve
spares forecasting*

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The heart of the matter

A forecast for
improvement

The recent global recession made a profound impact on business and industry worldwide, and commercial aviation was no exception. As economies began to regain their holds in 2010, the travel and logistics industries enjoyed renewed growth. However, with this upswing came concerns about the readiness of maintenance, repair, and overhaul (MROs) to meet operator expectations for delivery and reliability. These concerns were most noticeable as to the validity of spares forecasting demand to satisfy overall value chain needs.

Driven by an intense asset and working-capital environment, companies must proactively manage changing demands to reach their goals for continued growth and customer satisfaction. Demand forecasting information and the resulting inventory, manufacturing, and MRO capacity to meet the predictable and unexpected needs of the commercial aviation market are critical as growth expands. PwC has worked with industry leaders to understand best practices and forthcoming next practices to improve spares forecasting. Our examination of the leading indicators determined through the survey methodology has led to the findings and recommendations discussed in this whitepaper.

Key findings

- Successful spares planning and forecasting needs more effective collaboration and sharing of information (fleet data, engineering change orders, part reliability, service bulletins, etc.) across the supply chain.
- The adoption of best practices for spares planning bills of material (BOM), demand aggregation, and software enabling capabilities shows a low maturity level. This is impacting internal and external key performance indicators across the service value chain.

Key recommendations

- Focus on high-value data and special-factor drivers to compress data-sharing cycle time, improve data quality, and remove barriers.
 - Aggregate fleet data
 - Macroeconomic indices
 - Engineering data drivers
- Implement the following best practices to improve the overall maturity of the spares forecasting value chain:

- Ensure monthly Sales, Inventory, and Operations Planning (SIOP) process is used to integrate the overall customer demand.
- Forecast spares planning BOMs can improve integration and management of changes over the spares planning time horizon.
- Procurement release time fences (i.e., boundaries between different periods in the planning horizon) improve supply chain communication and reduce risk.

The following discussion details the survey results and identifies similarities and differences between OEMs, operators, and 3rd party MROs.

An in-depth discussion

The industry in context

Demographics and accountability

Commercial aviation spares forecasting touches every aspect of manufacturing—materials, processing, machining, and assembly—from large corporations with revenues greater than \$1 billion to locally owned specialty suppliers with revenues less than \$1 million. The demand signals for either end of the supply chain are generated from operators who serve passenger and cargo transportation business.

These signals flow from operators’ internal MRO facilities or 3rd party

MRO houses to the original equipment manufacturers (OEMs) or Tier 1 suppliers who in turn reach down to suppliers who specialize in processing and machining. In deciding from whom to seek spares forecasting information, PwC elected to focus the survey on OEMs, 3rd party MROs, and operators. These segments of commercial aviation represent the majority of the receivers of demand and are the agents who push initial demand through the supply chain.

As shown in Figure 1, the majority of companies that responded to the survey (45%) have less than \$500 million annual sales revenue, and approximately one-third of respondents

had business revenues greater than \$1 billion. Seven of the top 20 MROs with revenues greater than \$1 billion were included in the findings.

Figure 2 shows that approximately 65% of respondents were commercial only, while 35% operate in the commercial and defense market segments. The community had a fairly close distribution when looking at the OEMs, operators, and 3rd party MROs, as illustrated in Figure 3. These demographics suggest a diverse industry cross-section that is highly representative of the demand and receiving spectrums of the industry and supply chain as a whole.

Figure 1: Size of business

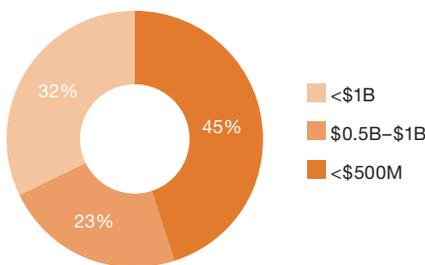


Figure 2: Market segments

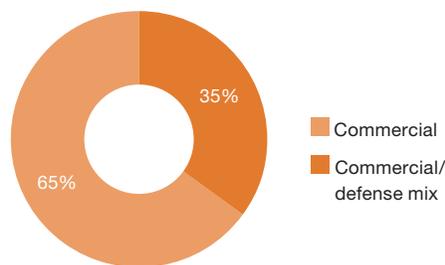
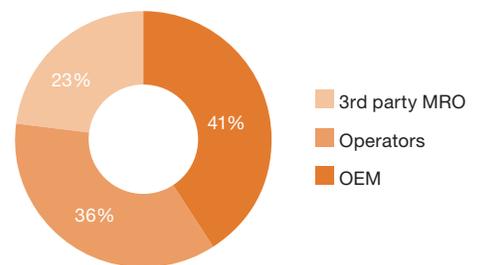


Figure 3: Distribution of respondents



Further, as shown in the break-out of Figure 4, we note all elements of the spares work stream, from component MRO to line maintenance and heavy maintenance activities. Each of these elements has unique as well as common issues regarding the driving forces of spares forecasting. These forces will be discussed in the following sections of this paper.

First, let's address the source of the demand stream as it relates to supply chain maturity. Over the past couple of decades we've seen a move toward consolidation within the aerospace

community. Enterprise resource planning (ERP) has emerged as a business tool to identify common processes and standardize policies and procedures. This poses the initial series of questions regarding 'accountability' within the organization for spares planning. We note in Figure 5 that forecasting is controlled primarily at the business unit level, as compared to at the corporate level. Further, if site-specific and program-specific spares planning are directly related to a business unit, then 78% of spares forecasting is influenced at the business unit level. Therefore, a corporate

lead business process enabled by business unit implementation of spares forecasting methodology should be the desired state.

For example, one of our respondents has seven business units all supporting the aerospace market. They all contribute to the bottom line, but the specifics of each business unit dictate a different forecasting methodology. We would not expect the same model to hold true for aircraft interiors and fuselage structural components, any more than we would expect similar modeling to address engine parts

Figure 4: Maintenance tasks

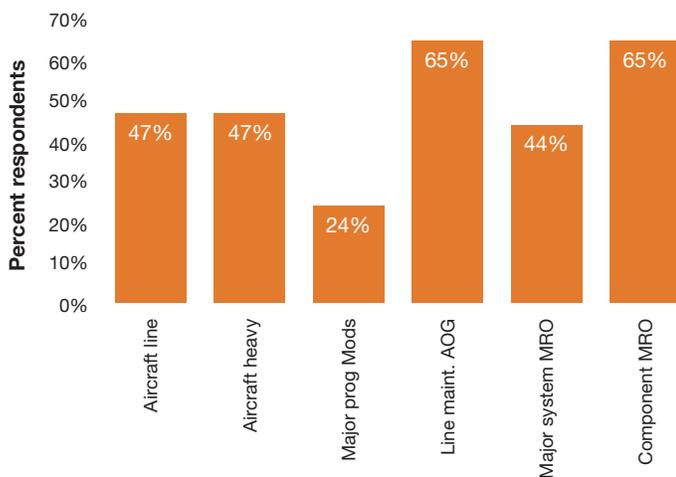
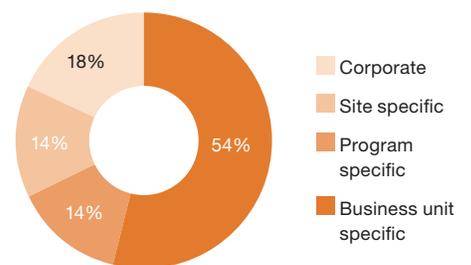


Figure 5: Control of spares planning scope



and electronic circuit boards when considering life-limited parts and part obsolescence. The point being that while ERP systems drive common processes, tailoring of those processes for market niches is required for business unit autonomy based on their products.

Digging deeper into the accountability question, we asked which business function was accountable for the financial forecast, the hardware forecast, and the hardware inventory. Using a Six Sigma tool called the RACI

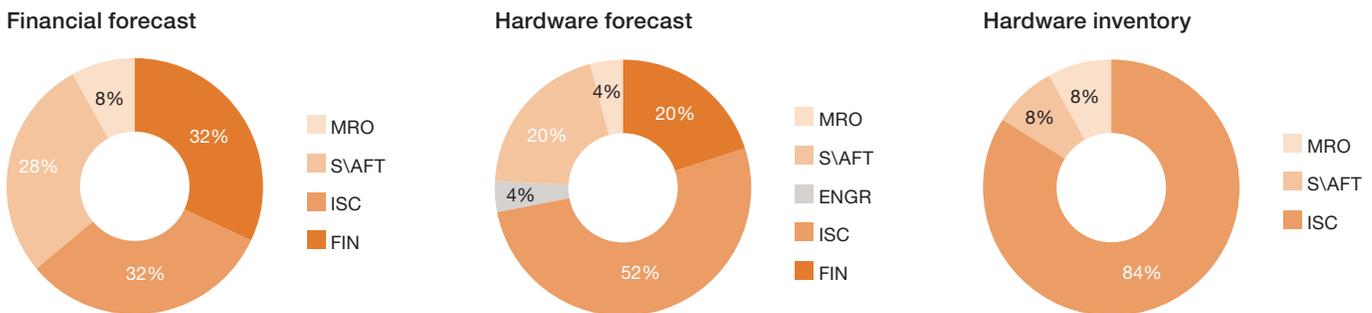
matrix (Responsibility, Accountability, Consulted, and Informed), we segregated responses by functional areas.

Not surprisingly, the Integrated Supply Chain (ISC) function was stated as being accountable by all segments of the survey population, as shown in Figure 6 for hardware forecasting and inventory. When looking at the financial forecast responsibility results, we see an equal split reported between ISC, Finance, and Sales/Aftermarket; however, ISC was the prime responsible party to both of these functions.

Improvement opportunities

As the ISC organizations continue to mature in their role of prime accountability for spares forecasting, inventory and financials awareness of the tools they employ is paramount to success. As will be discussed in later sections, rigorous process control around monthly Sales Inventory Operations Planning (SIOP), Engineering Change Order (ECO) flow down, procurement release time fences, supplier collaboration forums, and effective use of forecasting enablers will aid overall value chain effectiveness.

Figure 6: Spares planning accountability



Maintenance, Repair and Overhauls (MRO); Sales/Aftermarket (S/AFT); Integrated Supply Chain (ISC); Engineering (ENGR); Finance (FIN)

Business process importance

Spares forecasting has strategic as well as tactical components and is itself a critical component within other business processes. This section focuses on:

- Business processes affected by spares forecasting
- Effectiveness of these business processes
- Customer and internal business drivers important to these processes
- Business process improvement tools

As shown in Figure 7, when questioned about the importance of spares forecasting and its relationship to other processes, survey respondents indicated that the following annual business processes were highly effective:

- Annual inventory forecasts
- Annual operation plan
- Annual cash forecast
- Annual strategic plan

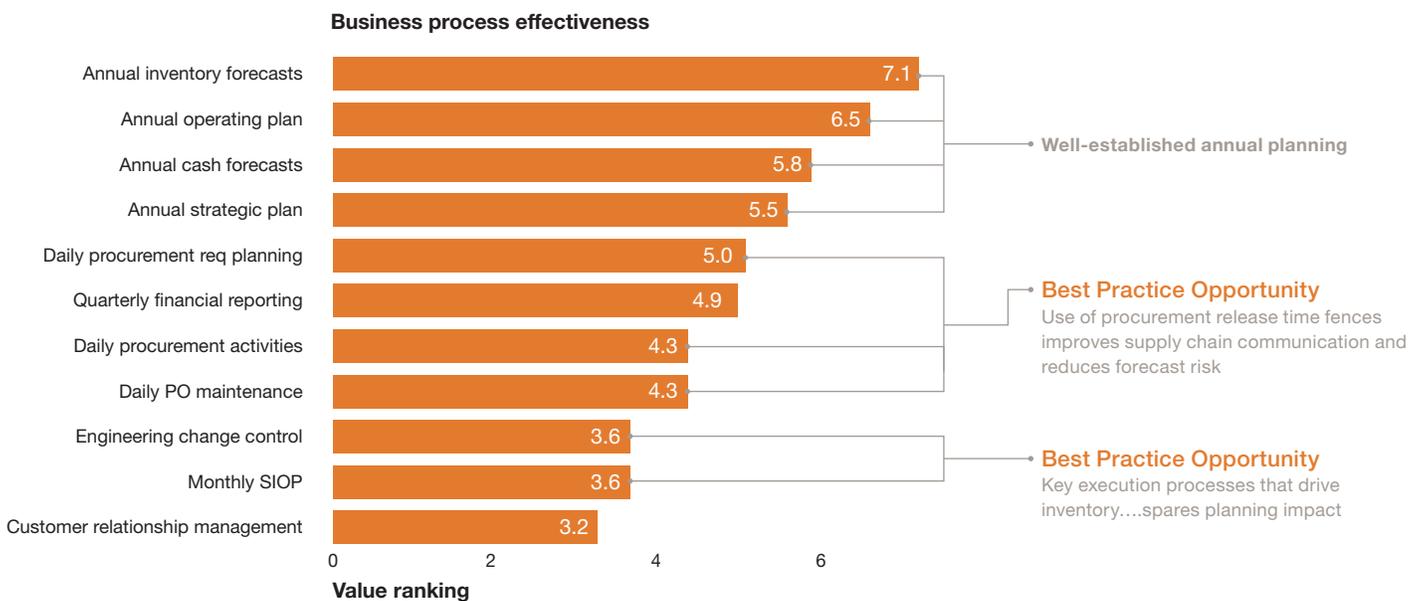
However, of significant note is the low business process effectiveness of the monthly SIOP process and the engineering change control (ECC)

process. Both of these processes affect spares planning and can be significant inventory drivers. As discussed throughout this report, engineering data impacts are a common improvement theme.

In addition, respondents recognized the importance of effective procurement processes, such as:

- Daily procurement requisition planning
- Daily purchase order add, change, delete
- Daily procurement demand add, change, delete with release

Figure 7: Key business processes impacted by spares forecasting



However, responses indicate that further improvements can be made by using procurement release time fences to improve planned requirement communication and reduce forecast risk. Results of respondent procurement time fence utilization across the three segments indicated the following:

- 50% use traditional firm procurement release practices with no time fencing
- 30% use procurement release practices with time fencing
- 20% use procurement release practices with time fencing and just-in-time signals

With the key business processes impacted by spares forecasting identified, and the effectiveness of the processes measured, let's now examine the important customer and internal business drivers. As shown in Figure 8, OEMs, operators, and 3rd party MROs agreed that the following metrics were of high importance:

- Fill rate or aircraft availability with budget constraint
- Customer satisfaction targets
- Internal MRO turnaround time (TAT) goals
- Aircraft on ground (AOG) fill rate with budget constraint

We considered rotatable pool inventory repair/buy plans and initial provisioning to be in this grouping because the above metrics are typically driven through contract performance/penalty terms from the aircraft manufacturer and/or operators to our OEMs for contract acceptance and award.

Thus, a series of questions arises about what factors are being used in current best practice and next-practice thinking in order that the demand streams can be met in the most cost-effective manner. The survey collected information regarding process improvement tool usage and effectiveness data, which we then

Figure 8: Key business driver considerations in spares planning

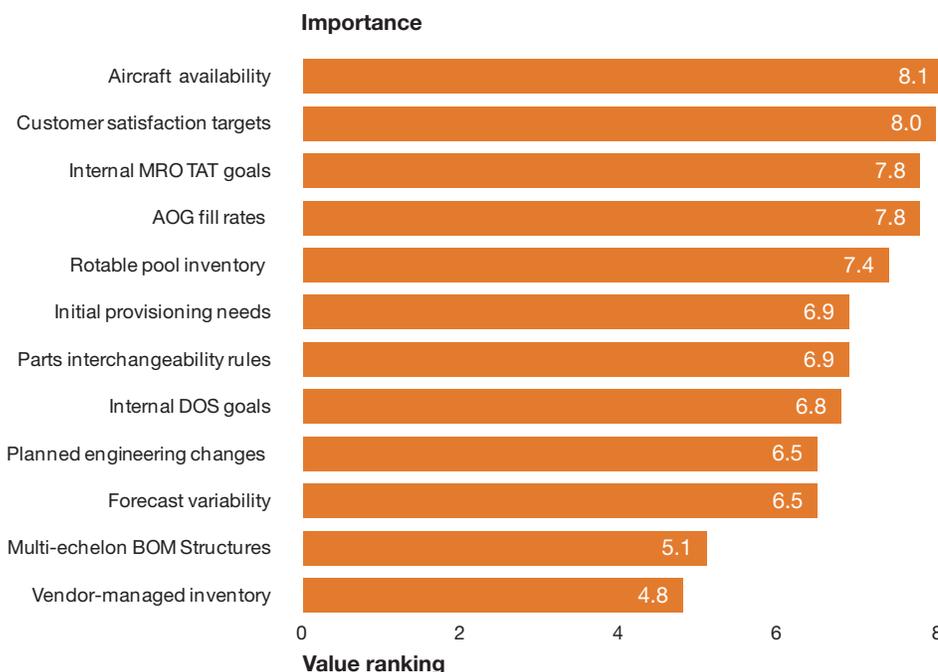
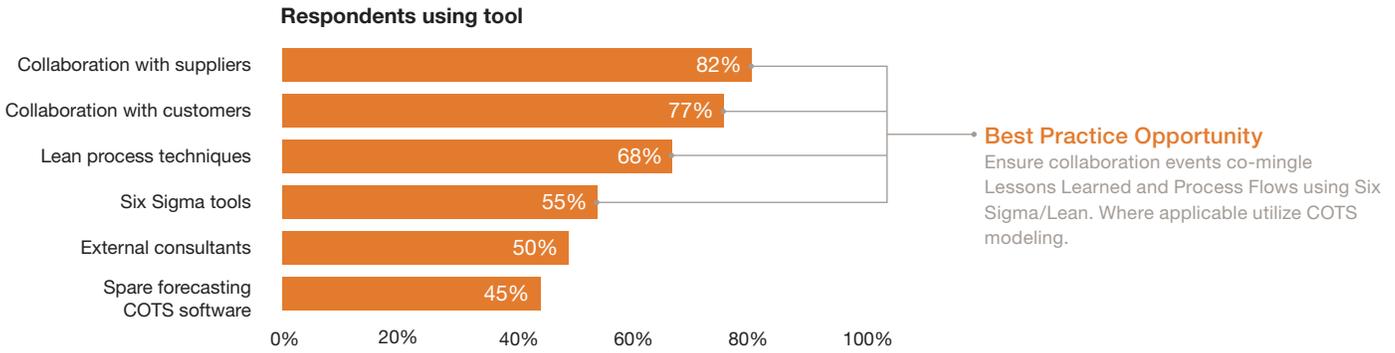


Figure 9: Commercial aviation view of spares planning process improvements



applied to business process and driver observations. As shown in Figure 9, with what might be considered some “low-hanging fruit,” all respondents viewed collaboration with their suppliers and customers as the key elements in deriving information and using that information to meet their contractual obligations.

Sharing of information helps everyone meet their respective obligations and promotes successful relationships, enhancing cost-effective delivery. It was interesting to note that respondents using Six Sigma tools and

Lean process techniques placed more value on those processes than what was obtained with communication/collaboration alone. Respondent input shows that, when collaboration and communication occurred via process flow methods throughout the value chain, companies gained an end-to-end perspective that enhanced spares forecasting. In addition, business process models provided by forecasting COTS suppliers had less than 50% usage. However, those respondents that did use the COTS supplier models valued them highly when making process improvements.

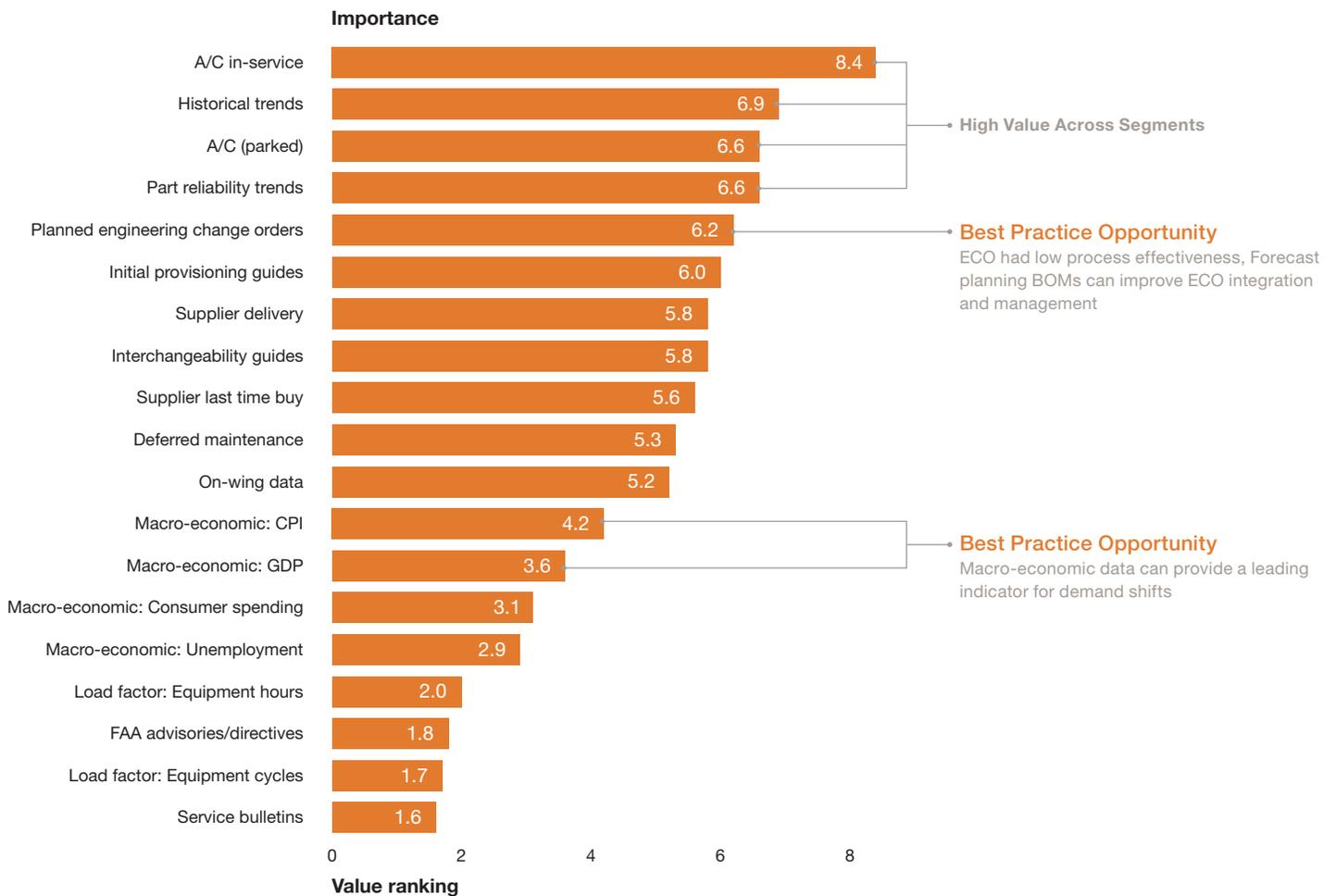
Business process data drivers

Spares forecasting requires various types of internal and external data collection prior to using manual and/or statistical-based forecasting tools. The timeliness, accuracy, and

proper weighting of the internal and external data are critical to forecasting accuracy and mitigating downstream supply chain risks. Various data types were identified during the survey methodology phase using industry perspective interviews, literature research, and internal PwC subject matter experts. Companies were asked

to rank the importance they placed on each data type in their planned/unplanned forecasting process. The data drivers were then ranked by descending mean score value of importance to the forecasting process, as shown in Figure 10.

Figure 10: Overall ranking of spares forecasting data drivers



Additional input provided by respondents included:

- The fact that OEMs and suppliers gather data in different ways
- A need to improve data accuracy
- The need for easier access to OEM reliability data

Let’s examine the ranking and, where applicable, correlate to observations made in other sections. We’ll then discuss opportunities to address the improvement of timeliness, accuracy, and availability of data across the value chain.

OEMs, operators, and 3rd parties have a high correlation across the top data

drivers. Figure 11 shows how each of the segments ranked the value of their top six data drivers.

The data drivers are displayed in mean value ranking by segment. Number and type of aircraft out-of-service and supplier last-time buy were the only data drivers not common across two of the three segments. Readily available data (i.e., number and type of aircraft in-service, historical trends, and number and type of aircraft out-of-service) provided the greatest value in the forecasting process.

When correlating planned engineering change orders (ECOs), value to bill of material (BOM) integration maturity (discussed in *Risk mitigation*), and

ECO business process effectiveness (discussed in the *Business process importance* section) improvement opportunities exist, especially in BOM integration. To improve ECO process effectiveness, companies should consider usage and integration of various MRO BOM types, such as as-built, as-maintained, master parts list, etc., as critical inputs to spares planning BOMs. Note that service bulletins provided little value in forecasting. However, this again may be due to the lack of maturity in spares planning BOM usage, which should include issued and pending service bulletins involving hardware changes integrated from various MRO BOM types.

Figure 11: High-value data drivers by segment

OEMs	Operators	3rd Party MROs
Number and type of A/C in-service	Number and type of A/C in-service	Number and type of A/C in-service
Historical trends	Supplier reliability for delivery	Historical trends
Number and type of A/C out-service	Planned engineering change orders	Part reliability trends
Part reliability trends	Interchangeability guides	Planned engineering change orders
Supplier last-time buy	Initial provisioning guides	Supplier reliability for delivery
Initial provisioning guides	Part reliability trends	Interchangeability guides

Respondents noted that part reliability trend data was important but may not provide a total view unless aggregated at the OEM level.

And further, making this improvement available across the entire MRO value chain can provide:

- Total quality view across all three segments
- Valuable product improvement input
- Indicators for preventive maintenance changes
- Ordering factor changes in spares planning BOMs

Figure 12 shows how each of the segments ranked their medium-value data drivers.

Macro-economic indicators had lower than expected value on the data importance scale. By comparing these

indicators over time and using the results to adjust forecast sensitivity, these indicators can provide advanced warning to demand shifts. In addition, macro-economic indices can provide near-term value because this data is easily obtained, accurate, and country specific. Descending values by country can provide global and/or regional, upward, or downward early warning notifications.

On-wing prognostics is a common theme to improve data quality and reduce notification cycle times. Coupling this with the ability to improve the ECO process across the value chain and using the data in spares planning BOMs can potentially compress cycle times for irregular maintenance activities. For example, accelerated unplanned maintenance actions (discussed in section, *Other business process drivers*), which had a high special-factor importance in the

forecasting process, can be hindered due to lack of hardware availability stemming from the non-use of spares planning BOMs.

Improvement opportunities

The survey reveals the following business process data driver improvement opportunities:

- OEM early warning notification of ECOs can improve operator and 3rd party MRO integration of master parts list to spares planning BOMs.
- Part reliability trend data aggregated at the OEM can provide total quality view across segments.
- Macro-economic data provides a leading indicator for demand shifts. Incorporation of macro-economic factors where appropriate to adjust shifts.
- On-wing prognostics can improve data quality and reduce data transfer cycle time.

Figure 12: Medium-value data drivers by segment

OEMs	Operators	3rd Party MROs
On-wing data (prognostics)	Deferred maintenance action history	Number and type of aircraft out-service
Macro-econ price indices	Number and type of aircraft out-service	Initial provisioning guides
Planned engineering change orders	Historical trends	Deferred maintenance action history
Interchangeability guides	Supplier last-time buy	Supplier last-time buy
Macro-econ: GDP	On-wing data (prognostics)	On-wing data (prognostics)
Deferred maintenance action history	Macro-econ: price indices	Macro-econ: GDP
Supplier reliability for delivery	Load factor: A/P/C equipment hours	Macro-econ: price indices

Other business process drivers

Special-factor drivers

In addition to the business process data drivers discussed in the previous section, special-factors can be used to sensitize the spares forecast based on internal metrics and customer data. Aggregate fleet information provides the greatest value in the forecasting process. Knowledge of aircraft coming

out of service or entering service provides significant information for adjudicating spares ordering policies, specific parts, or quantity of parts. As shown in Figure 13, fleet information receiving the highest marks as potential influencers are:

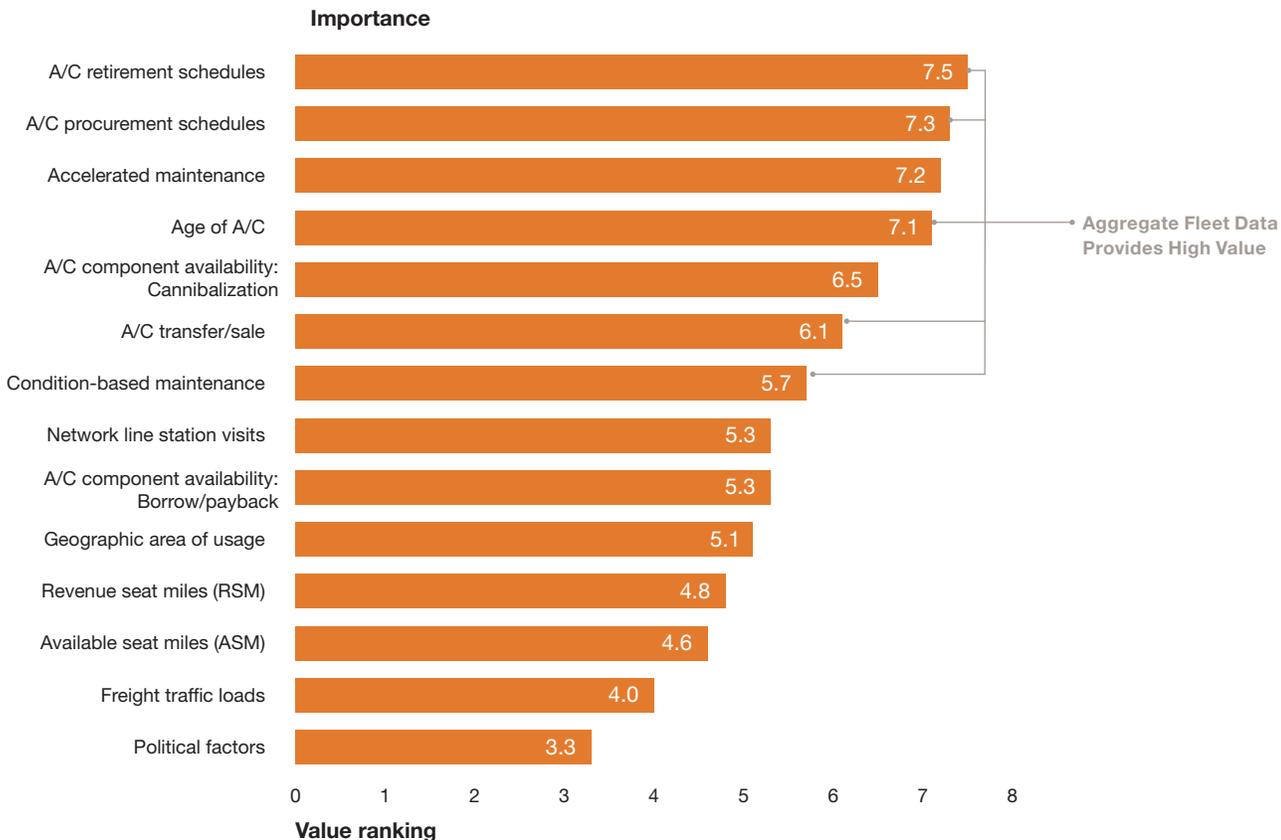
- Aircraft leaving inventory
- Aircraft entering service
- Demographics (age, location of service, utilization, etc.)

- Aircraft being transferred in or sold out of inventory

Respondents commented that a broader sharing of standard fleet information in a common format would enhance the industry and should be considered a standard going forward.

In analyzing the data, we looked for cross-correlation and consistency in responses. Figure 14 shows that each market segment provider is in

Figure 13: Overall value ranking of spares forecasting special-factor drivers



agreement with the high-value drivers, with some variation in position when ranked by mean-value scoring. And across the board, without considering rank, operators and 3rd party MRO houses are in absolute agreement on the high and medium special-factors. The OEMs favor tailoring their forecast with internally gathered passenger data, such as available seat miles and revenue seat miles. In addition, OEMs of engines, landing gear, structures, etc., may use load-factor data to tailor

their planning more effectively than line-station visits or borrow/payback.

Figure 15 shows that the relative ranking order of high-value special-factors can be considered a function of the workstream between each of the segment respondents. For example, OEMs normally have prime responsibility for parts in the supply chain sent to operators and 3rd party MROs. Therefore age, procurement, and retirement are key special-factors.

Further, OEMs are typically responsible for service bulletins, part reliability improvements, part obsolescence, and repair practices. Therefore, it makes sense that operators and 3rd party MROs want to optimize each scheduled aircraft visit, since they look downstream for maintenance actions associated with these special-factors that might necessitate additional maintenance, hence the relative ranking of accelerated maintenance.

Figure 14: Value of spares forecasting special-factor drivers by segment

	OEMs	Operators	3rd Party MROs
High	Age of aircraft	Aircraft retirement schedules	Accelerated maintenance
	Aircraft procurement schedules (new inductions)	Aircraft procurement schedules (new inductions)	Aircraft retirement schedules
	Aircraft retirement schedules	Network line station visits	A/C component availability cannibalization
	Available Seat Miles (ASM)	Accelerated maintenance	Age of aircraft
Medium	Revenue Seat Miles (RSM)	Age of aircraft	Aircraft component availability from borrow/payback
	Accelerated maintenance	Aircraft transfer and/or sale schedules	Aircraft procurement schedules
	Condition-based maintenance	Aircraft component availability cannibalization	Aircraft transfer and/or sale schedules
	A/C transfer or sale schedules	Aircraft component availability from borrow/payback	Condition-based maintenance
	A/C component availability cannibalization	Condition-based maintenance factors	Network line station visits
Low	Freight traffic loads	Geographic area of usage	Geographic area of usage
	Geographic area of usage	Revenue Seat Miles (RSM)	Revenue Seat Miles (RSM)
	Network line station visits	Freight traffic loads	Political factors
	Political factors	Available Seat Miles (ASM)	Available Seat Miles (ASM)
	Aircraft component availability from borrow/payback	Political factors	Freight traffic loads

NOTE: Data is ranked in descending order by mean

Data source drivers

After ranking the various types of data and special-factors by importance, operators, OEMs, and third parties then indicated how they rank the value of the data obtained from various internal and external sources.

The value of information from the data and special-factor sources is illustrated in Figure 16. In March 2006, the Aberdeen Group published “The Convergence of People and Parts in the Service Chain.” The paper indicated that a high percentage of companies had loosely aligned field technicians and service parts planning. Note that the commercial aviation respondents in this study indicated a high value was given to internal MRO and internal field operations input to the spares planning process. This is a

good indicator that field technicians (internal field operations) and internal MRO are becoming more aligned with the service parts planning function.

Referencing Figure 16, note the ranking of the internal aircraft logbook record. In the *Business process data drivers* section we saw high value placed on part reliability trends and medium value assigned to on-wing prognostics across all three segments. OEMs and 3rd party MROs placed little value on internal aircraft logbook records. Potentially, there is some data intersection between on-wing prognostics and the internal aircraft logbook record, which both feed downstream processes impacting part reliability trends. The survey did not collect enough information to justify further investigation of this topic.

Figure 17 decomposes the data sources ranking by OEMs, operators, and 3rd party MROs. In the high-value data sources, 3rd party data repositories and internal aircraft logbook records were the only data items not common across the three segments. However, 3rd party data repositories ranked fifth and sixth by OEMs and 3rd party MROs, respectfully. Value chain collaboration and internal operations ranked as the highest value information source for spares planning.

Let’s examine opportunities within the high-value data drivers. As shown in Figure 18, value chain collaboration ranked high across all segments. In addition, collaboration with customers or suppliers ranked as an effective process improvement tool, as noted in the *Business process importance* section.

Figure 15: High-value spares forecasting special-factor drivers

OEM	Operator	3rd Party MRO	
Age of aircraft	Aircraft retirement schedules	<i>Accelerated maintenance</i>	Best Practice Opportunity Accelerated Maintenance has High value for Operators and 3rd Party MROs. However, Service Bulletins had low value as a data driver. Service Bulletin linkage to Accelerated Maintenance is critical for efficient bundling of maintenance events.
Aircraft procurement schedules (new inductions)	Aircraft procurement schedules (new inductions)	Aircraft retirement schedules	
Aircraft retirement schedules	Network line station visits	Aircraft component availability cannibalization	
Available seat miles (ASM)	<i>Accelerated maintenance</i>	Age of aircraft	

NOTE: Data is ranked in descending order by mean

Figure 16: Spares forecasting data/special-factor information source value

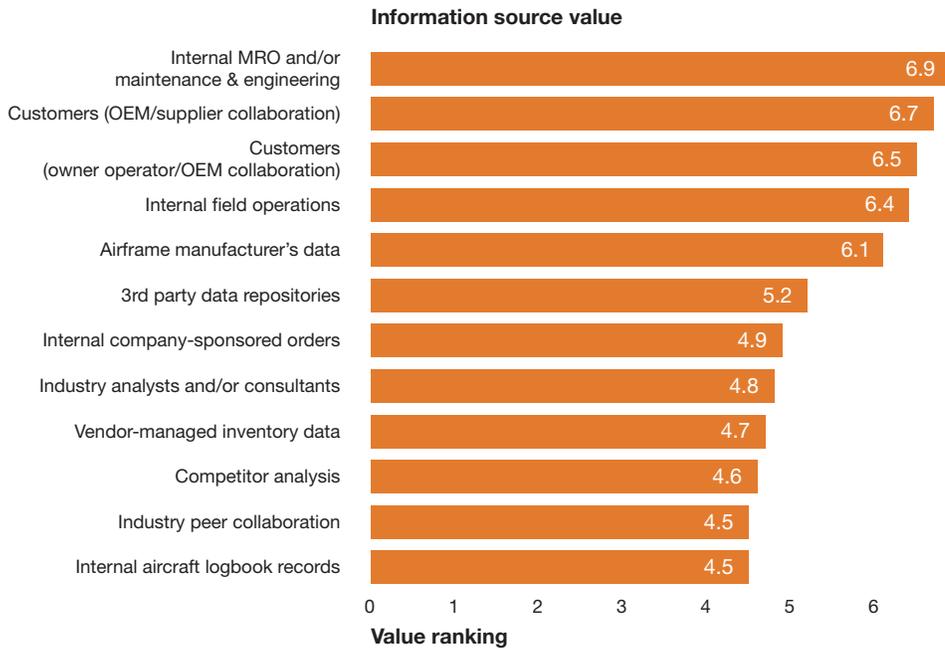


Figure 17: Data/special-factor information source value by segment

	OEMs	Operators	3rd Party MROs
High	Customers (OEM—supplier collaboration)	Airframe manufacturer's data	Internal MRO and/or maintenance & engineering
	Internal MRO and/or maintenance & engineering	Internal MRO and/or maintenance & engineering	Customers (owner operator—OEM collaboration)
	Customers (owner operator—OEM collaboration)	Internal aircraft logbook records	Internal field operations
	Internal field operations	Internal field operations	Customers (OEM—supplier collaboration)
	3rd party data repositories	Customers (OEM—supplier collaboration)	Airframe manufacturer's data
Medium	Industry analysts and/or consultants	Internal company-sponsored orders	3rd party data repositories
	Airframe manufacturer's data	Customers (owner operator—OEM collaboration)	Internal company-sponsored orders
	Competitor analysis	Vendor-managed inventory data	Industry peer collaboration
	Vendor-managed inventory data	Industry analysts and/or consultants	Internal aircraft logbook records
Low	Internal company-sponsored orders	Competitor analysis	Industry analysts and/or consultants
	Industry peer collaboration	3rd party data repositories	Vendor-managed inventory data
	Internal aircraft logbook records	Industry peer collaboration	Competitor analysis

NOTE: Data is ranked in descending order by mean

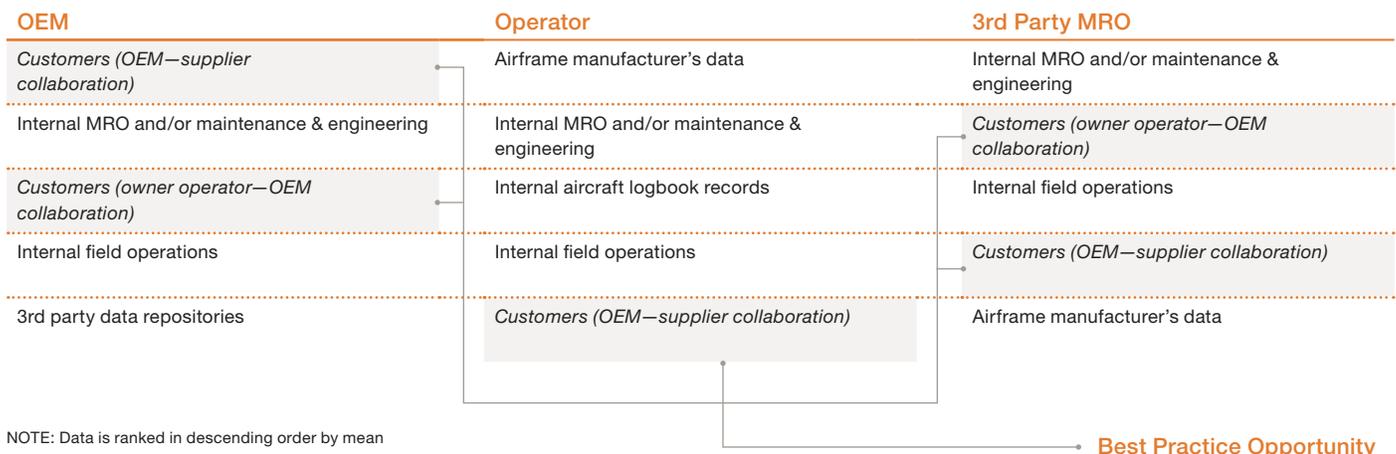
Improvement opportunities

Value chain improvement efforts to compress data-sharing cycle time, improve data quality, and remove barriers should focus on the following common-interest items across the value chain, as discussed in the business process and data sections:

- Aggregate fleet data distribution can improve OEM spares planning reaction time and fill-rate commitments.
- Part reliability trend data aggregated at the OEM can provide total quality view across segments.
- OEM early warning notification of ECOs can improve operator and 3rd party MRO integration of master parts list to spares planning BOMs.
- On-wing prognostics can improve data quality and reduce data transfer cycle time.

Capitalizing on the high value of collaboration as a data source and as a business process improvement tool can foster successful improvements in these common-interest areas.

Figure 18: Highest valued data/special-factor information sources



Best Practice Maturity

Utilization of field service and internal operations as a vital data source for service parts planning, well established since March 2006 Aberdeen Group Best Practice highlight in "The Convergence of People and Parts in the Service Chain"

Business process software enablers

Earlier we looked at key business process drivers and their importance in the spares forecasting process. Software capabilities can enable these drivers. Respondents were asked to rank the importance of business driver software capabilities, as shown in Figure 19.

The drivers considered to be customer facing and key to internal improvement efforts carried the highest importance. One minor misalignment with business drivers versus software capability was the ranking of engineering changes. However, this may be due to the level of BOM integration maturity, which will be shown later.

There was no significant difference in the value ranking of business drivers important to spares forecasting and the software capabilities required to enable those drivers, as shown in Figure 20.

During interviews with commercial off the shelf (COTS) forecasting software providers, which will be discussed in

Figure 19: Importance of spares forecasting software capabilities

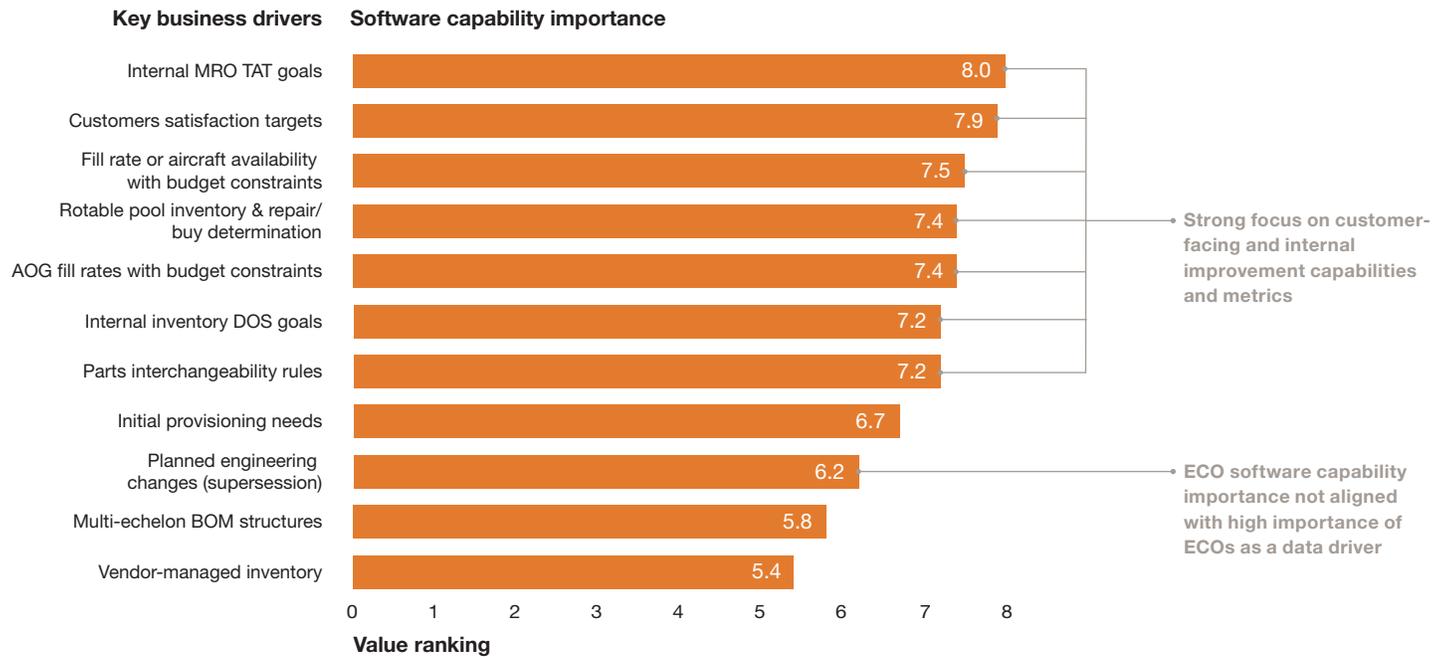
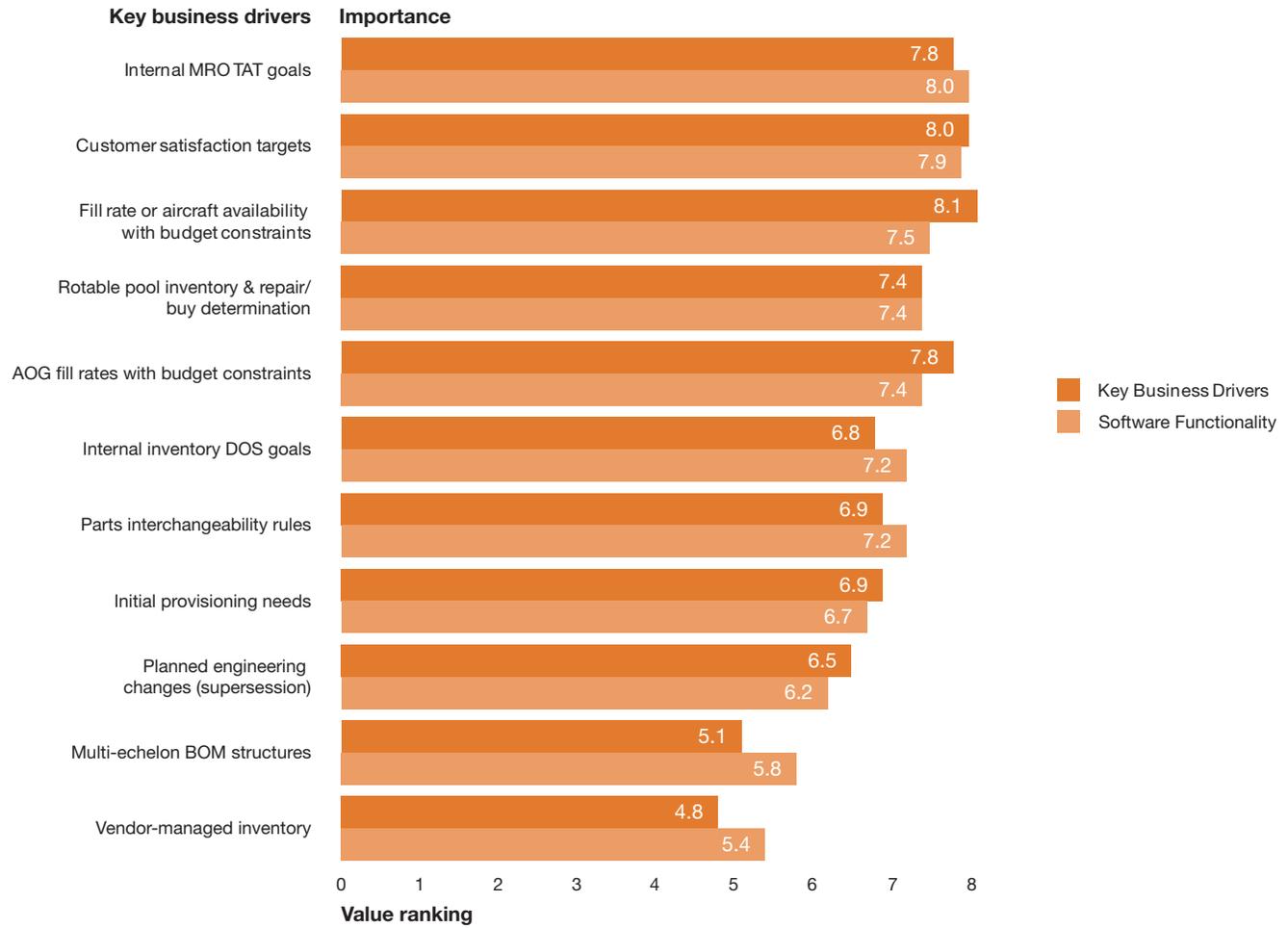


Figure 20: Alignment of forecasting business drivers and software needs



the *Research methodology* section, it was brought to light that many of the software capabilities required to enable key business drivers exist today. The COTS suppliers have done a good job of aligning capability with need.

Although we have seen excellent alignment between business drivers and software capabilities, there has

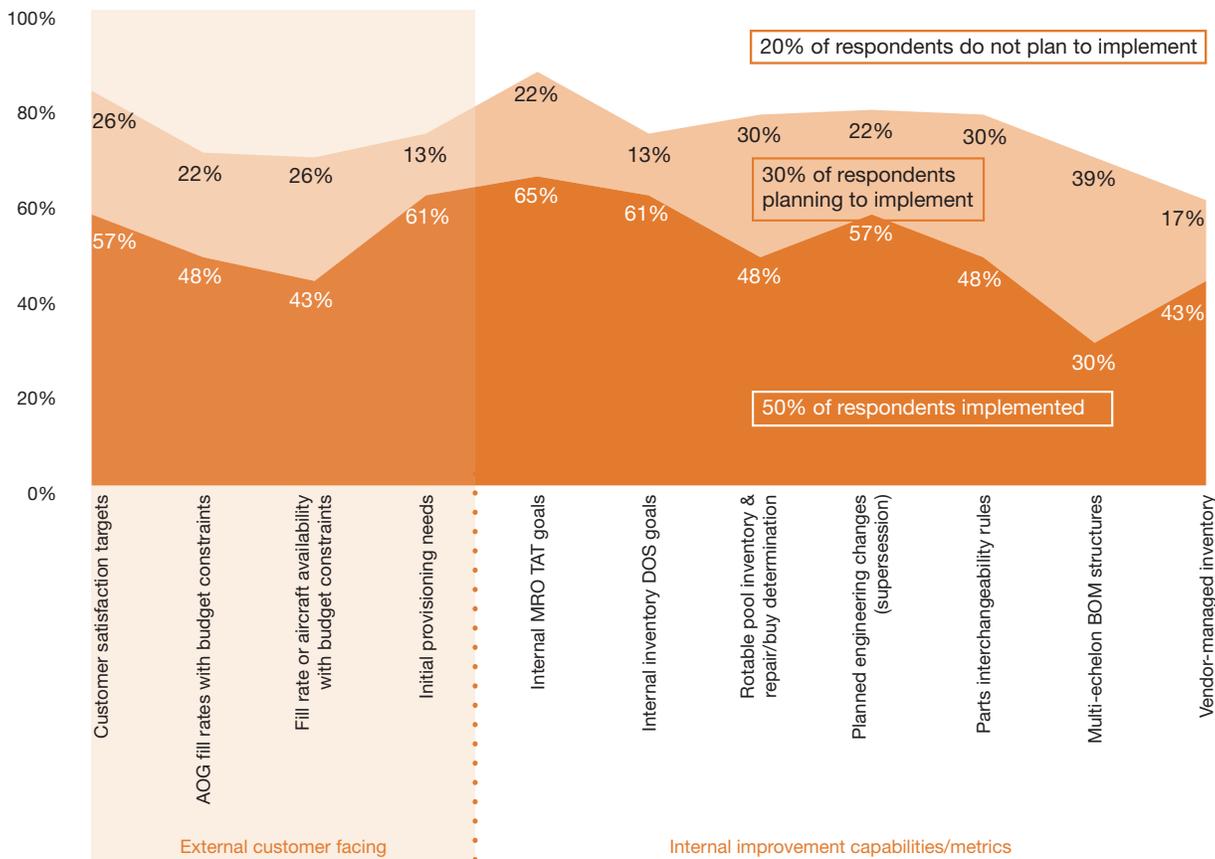
been a slow adoption rate of business driver software capabilities, as shown in Figure 21. Note that:

- 50% of respondents have implemented key software enablers, while
- 30% of respondents plan to implement within the next 36 months, and

- 20% of respondents have no plans to implement at this time.

Considering the slow adoption of basic software capabilities, using simulation to perform “what-if” of the basic capabilities has an even lower process maturity across the value chain.

Figure 21: Implementation maturity of business driver software capability



The use of advanced capabilities of simulation to analyze data and/or parameter changes to the spare forecasting plan has only been adopted by 50% of the respondents, as shown in Figure 22. Of those respondents using simulation, 80% were OEMs and 3rd party MROs.

Improvement opportunities

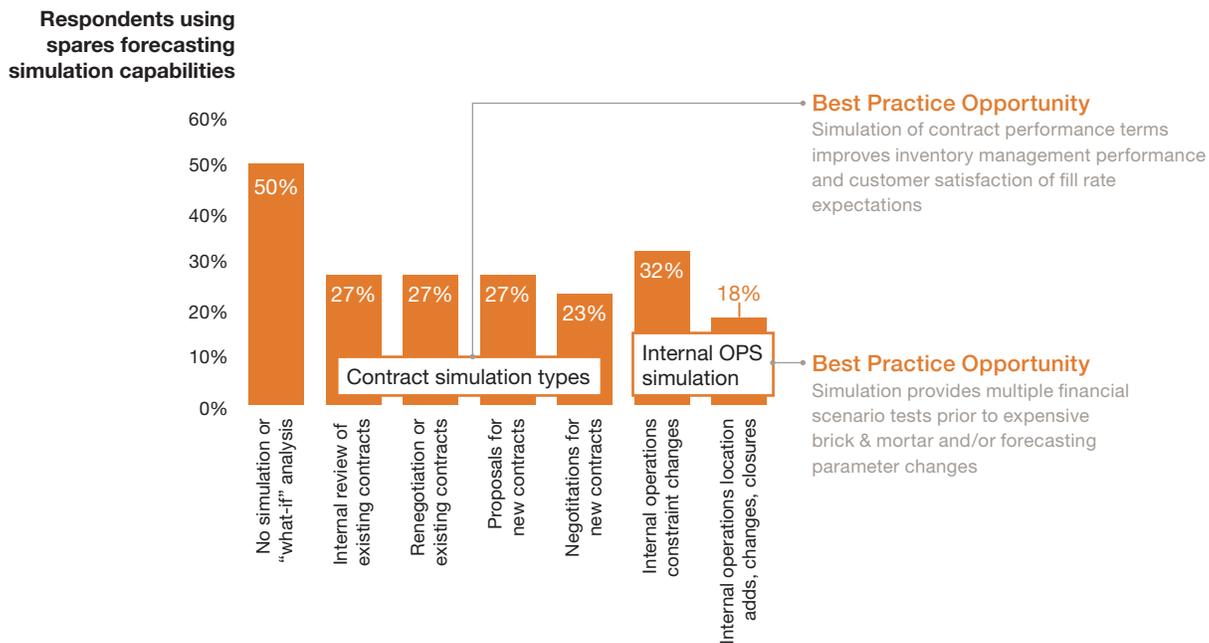
OEMs have focused their attention on using simulation for internal operations and contracts. This leads to two best practice opportunities across the value chain:

- Simulation of contract performance terms improves inventory

management performance and customer satisfaction of fill rate expectations.

- Simulation provides multiple financial scenario tests prior to expensive brick & mortar and/or forecasting parameter changes.

Figure 22: Implementation of advanced business driver software capability



Risk mitigation

Multiple business process maturity factors can impact spares forecasting risk mitigation and hinder overall asset utilization. We examined four key maturity factors that influence risk in the spares planning process:

- Scope of spares planning
- Demand aggregation
- MRO planning bills of material
- Supplier communication methods

Note that 18% of the respondents have implemented their spares forecasting software capabilities at the enterprise level, as shown in Figure 23.

As discussed in the *Demographics and accountability* section, enterprise application is more suited to ensure that a common business process can be used. This ensures that a business unit, program, or location business processes effectively use data drivers and special-factor drivers to enhance internal and customer-facing requirements. Ideally, the scope of spares planning should

be held within the business unit level, and, as stated previously, if we assume that program and location are part of the business unit attention needs to be paid or other maturity issues can arise, as discussed below.

As shown in Figure 24, demand aggregation across the enterprise had a low maturity.

Coupling the 59% of the respondents having limited or no customer demand aggregation across the enterprise with

Figure 23: Scope of spares planning

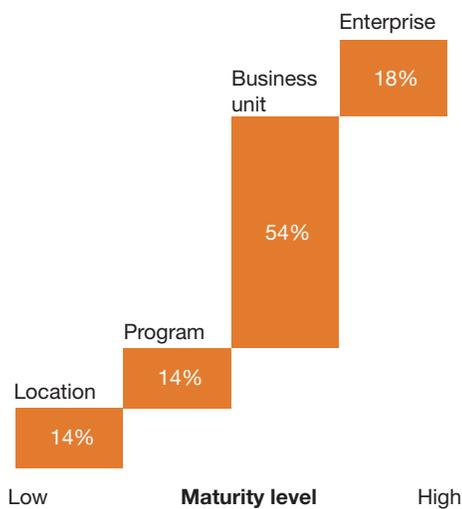
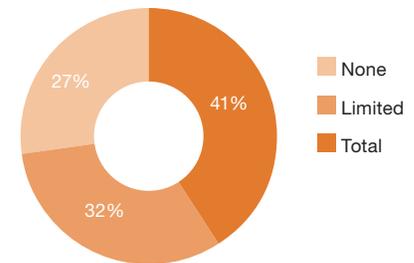


Figure 24: Level of demand aggregation



the scope of spares planning at the program or location level can cause:

- Loss of visibility to the customers total needs
- Negative impacts to downstream procurement processes

Engineering change control (ECC) has a high data value across all respondents, as shown earlier. However, due to low ECC process

effectiveness, 48% of the respondents continue not to integrate MRO planning BOMs into the spares forecasting process, as shown in Figure 25.

This lack of integration impacts the timely release of changes and has a negative impact on downstream procurement processes. The causes of low ECC process effectiveness were

not collected in this survey; however several items may be contributing:

- Organizational responsibilities for maintenance of BOM across the BOM life cycle
- Technology barriers to aggregate and integrate BOM data across various BOM life cycles
- Importance of MRO in the overall revenue of the enterprise

Figure 25: Bill of material life cycle across value chain

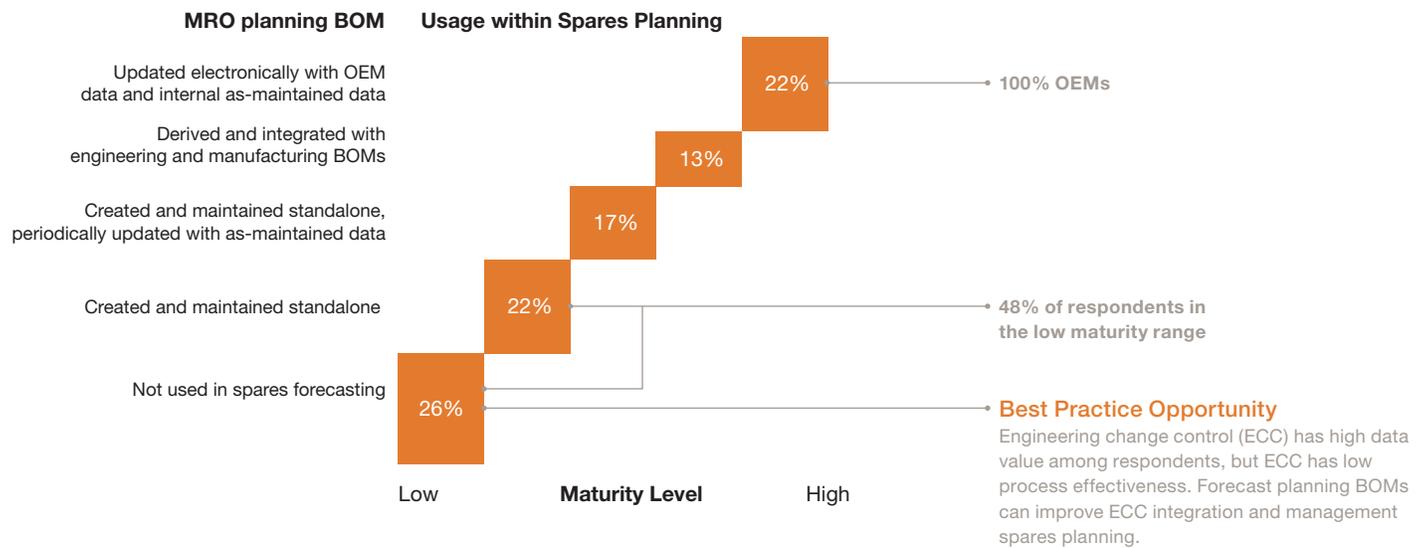
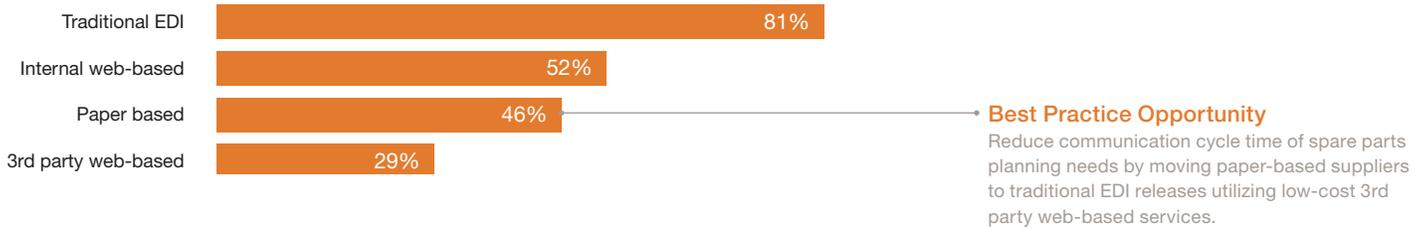


Figure 26: Procurement release communication methods



Timely and accurate communication of demand to the internal or external supplier base is critical. Figure 26 shows that traditional EDI is by far the most prevalent procurement release methodology used by the responding companies.

However, this technology has entry cost barriers for small- and medium-sized suppliers. These same concepts and data formats can be used to significantly reduce the paper-based releases used today.

Transitioning to cost-effective 3rd party web-based systems can reduce internal overhead and compress value chain

communication cycle time. Of note, 48% of respondents are transitioning to supplier on-site replenishment.

Finally, as discussed in the *Business process importance* section, respondents recognized the importance of effective procurement processes, especially daily procurement demand add, change, and delete releases.

Improvement opportunities

Responses indicate that further improvements can be made by using procurement release with time fences to improve planned requirement communication and reduce

forecast risk. Results of respondent procurement time fence utilization across the three segments indicated:

- 50% use traditional firm procurement release practices with no time fencing
- 30% use procurement release practices with time fencing
- 20% use procurement release practices with time fencing and just-in-time signals

Time fencing can enhance long-range procurement windows with material and labor commitments controlled by agreed time periods between buyer and seller.

What this means for your business

Conclusion

With the diverse implementation maturity of business processes and software capabilities across the value chain, we recommend that companies capitalize on the strong desire for collaboration by sharing improvement and implementation lessons learned within their peer supplier groups.

Figure 27: Summary of best/next practices

Business processes	Data/special-factors
<ul style="list-style-type: none"> • Ensure customer/supplier collaboration events co-mingle lessons learned and process flows using Six Sigma/Lean. Where applicable, use COTS process models. • ECC had low process effectiveness: ensure ECC importance is elevated, executed, and controlled across all BOM life cycle types. • ECC had low process effectiveness: Forecast planning BOMs can improve ECO integration and management of changes over the entire spares planning time horizon. • Monthly sales inventory operations planning (SIOP) had low process effectiveness: Ensure SIOP is a key process that integrates the overall spares planning needs. Increase overall demand aggregation planning. 	<ul style="list-style-type: none"> • Macro-economic data can provide a leading indicator for demand shifts. Incorporate macro-economic factors, where appropriate, to adjust shifts. • Accelerated unplanned maintenance had high value for operators and 3rd party MROs. However, service bulletins had low value as a data driver. Service bulletin linkage to accelerated unplanned maintenance is critical for efficient bundling of maintenance events. • Part reliability trend data aggregated at the OEM to provide total quality view across segments. • OEM early warning notification of ECOs to improve operator and 3rd party MRO integration of master parts list to spares planning BOMs. • On-wing prognostics to improve data quality and reduce data transfer cycle time.
Data sources	Software capabilities
<ul style="list-style-type: none"> • Increased utilization of field service and internal operations as a vital data source for service parts planning. • Use collaboration events to focus on high-value data and special-factor drivers to compress data-sharing cycle time, improve data quality, and remove barriers. 	<ul style="list-style-type: none"> • Strong focus on customer-facing and internal improvement capabilities and metrics. • ECO software capability importance not aligned with high importance of ECOs as a data driver. • Simulation provides multiple financial scenario tests prior to expensive brick & mortar and/or forecasting parameter changes. • Simulation of contract performance terms improves inventory management performance and customer satisfaction of fill rate expectations.
Risk mitigation factors	
<ul style="list-style-type: none"> • Use of procurement release time fences improves supply chain communication and reduces forecast risk. • Reduce communication cycle time of spare parts planning needs by moving paper-based suppliers to traditional EDI releases using low-cost 3rd party web-based services. 	

Research methodology

As explained in the *The industry in context* section, the importance of demand forecasting information and the resulting inventory, as well as manufacturing and MRO capacity to meet the predictable and unexpected maintenance within the value chain for commercial aviation, are critical as growth expands. To validate the state of commercial aviation spares forecasting, PwC captured key data to measure business processes, data types and sources, application software needs versus capabilities, and risk factors influencing maturity of business processes and software usage.

Figure 28 illustrates the data collection methodology we employed to ensure engagement with spares forecasting software providers and users of spares forecasting tools. The methodology focused on several key inputs:

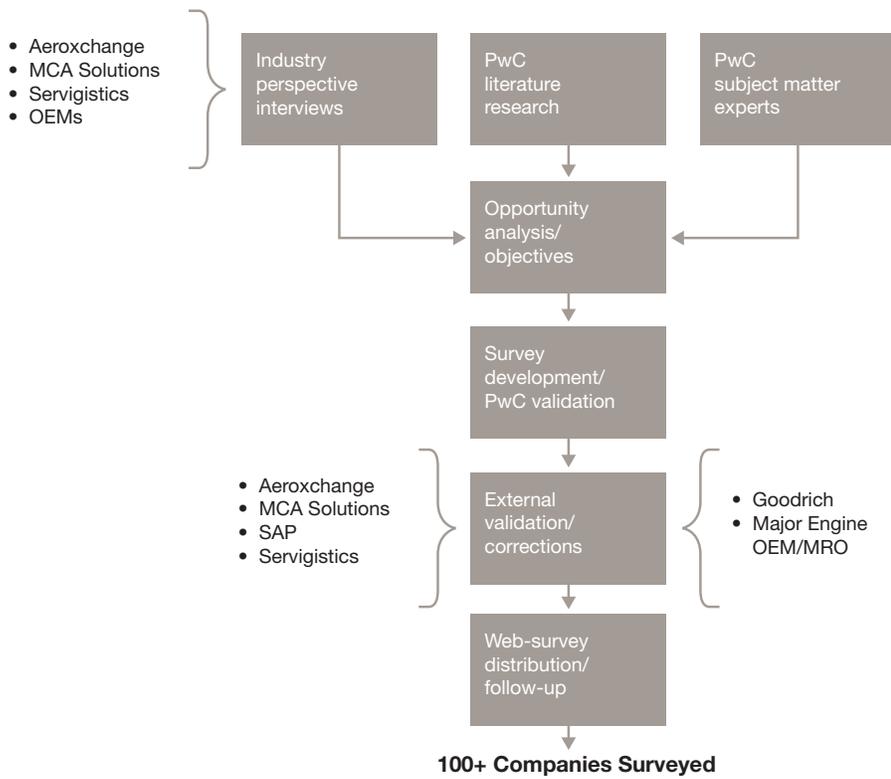
- Initial research included gaining an industry perspective with software providers and aviation OEMs, coupled with a review of industry literature and input from PwC subject matter experts.

- Survey development included cross-referencing questions to ensure responses could be correlated, especially in the areas of business process effectiveness, software capabilities, and software implementation maturity.
- Validation of the survey subject areas and content was conducted with software providers and aviation OEMs.

A secure, web-based survey tool was the primary data collection method. The survey segregated responses by OEMs, operators, and 3rd party service providers. The survey was deployed to over 100 commercial aviation companies with a three-month data collection time frame.

Data analysis, opportunity identification, presentation/whitepaper development, and internal PwC review activities were performed by multiple internal PwC subject matter experts over a four-month period.

Figure 28: Data collection methodology



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