IBM

Business Process Management for Automotive End of Life Processes

IBM Business Papers: Business Process Management Series

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Introduction

Automotive manufacturers in Europe are facing major changes to several processes. These processes include their new product introduction, manufacturing, and service after sales processes. The changes come in the wake of the European Union (EU) Directive 2000/53/EC on end of life vehicles (ELV) and Directive 2002/95/EC on the restriction of the use of hazardous substances (RoHS) in electrical and electronic equipment. Failure to reach regulation targets will cost each original equipment manufacturer (OEM) approximately 1 billion euros annually.

For details about the directives, see the following references:

- EU Directive 2000/53/EC

  http://eur-lex.europa.eu/LexUriServ/site/en/consleg/2000/L/02000L0053-20050701-en.pdf

- EU Directive 2002/95/EC

  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0095:EN:HTML

As the automotive industry continues to expand, the need for cost-efficient responses to regulation that strives for process efficiency grows increasingly important. According to IBM® research, the automotive industry shows the following trends:

- The global automotive industry continues to grow at 2.6% per year.
- In the next four years, the number of vehicles produced in the industry is expected to increase from 60 million to 70 million due to expansion in the global marketplace.
- The automotive industry accounts for 15% of the world's gross domestic profit with a US$31 billion aftermarket industry growing 6% annually and new product introductions up by 34% since 2004.

Thus as the automotive industry grows and adheres to new government regulations, it demands robust, flexible solutions that provide insight into business processes in order to remain competitive and profitable.

This paper illustrates how automotive manufacturers can use Product Lifecycle Management (PLM) and business process management (BPM), including business activity monitoring (BAM) methodologies and technologies, to develop and deploy optimized solutions. Such solutions will help address the carbon impact of the post-sales management of hazardous vehicle materials and recycling of the vehicle materials upon end of life.

This paper unites existing methods and technologies including process operational status, event correlation, aggregation, and predictive analysis. It explores future technologies that create a vision for addressing ELV environment challenges. It also outlines some of the dynamics that drive change in the automotive industry and discusses ELV environmental challenges that are facing the industry. PLM, BPM, and BAM are introduced along with the key technologies that are used by those disciplines and how they all come together in a PLM implementation. This paper then applies the methods and technologies to a case study about auditing the configuration of every vehicle that contains these hazardous materials and monitoring and reporting the effectiveness of recycling efforts.

Changing dynamics in the automotive industry

Marketplace growth, outsourcing product development activities, customer demands for improved reliability, human-vehicle interaction software, and competition are changing the dynamics in the automotive industry. The changes are brought on by the following driving forces (according to IBM research into the automotive industry):

- Marketplace growth

  In the next four years, the number of vehicles produced in the automotive industry is expected to increase from 60 million to 70 million due to expansion in the global marketplace. The automotive industry accounts for 15% of the world's gross domestic profit with a $31 billion aftermarket industry growing 6% annually and new product introductions up by 34% since 2004.

- Outsourcing

  Automotive product development activities are increasingly outsourced from OEMs, for example, automotive vehicle production and delivery companies such as Ford, Toyota, and Honda. By 2015, the prediction is that more than 75% of the value created in the industry will be driven by suppliers.

- Technology

  Customer demands for improved reliability and vehicles that use technology to improve the human-vehicle interaction are driving increased electronic and software content to account for 40% of the value of the vehicle by 2010. One focus in this area is on information technology, which includes the following topics:

  – Communication technologies

    Wireless, vehicle-to-vehicle and vehicle-to-base station, driver notification systems, telecommuting, and communications-assisted travel

  – Software

    Software safety and reliability for safety critical and high reliability systems

  – Embedded systems

    Onboard intelligence, vehicle systems integration, improved hardware-software synthesis, fault-tolerant, and fail-safe systems

  – Information systems

    Driver assistance systems, data security, confidentiality and privacy, economics of transportation-based systems, transportation management systems, and integrating humans into diverse sensor, communications, control, and information systems

  – Biotechnology

    Highly efficient diesel engines and optimized gasoline engines, new fuels from ethanol, biodiesel and hydrogen, and new power train technologies that use advances in hybrid and fuel cell applications

- Competition

  The automotive marketplace has become incredibly competitive. For example, for the OEMs to meet price, quality, and innovation challenges, they must continuously improve their end-to-end processes and ensure quality and integrity of data used at every point in the life cycle. OEMs are careful to leverage emerging marketplaces, especially in China and India, while maintaining customer satisfaction in traditional marketplaces.

Vehicle ELV-related environmental pressures on the industry

Another major dynamic in the automotive industry is how environmental and legislative requirements are changing the way in which the industry is managing vehicles to end of life. In investigating the automotive OEMs' core impact on the environment, two key areas are considered: carbon impact and vehicle end of life processes.

First, there is the operational execution of the OEM. That is how much energy the company uses to run its factories, offices, logistics efforts, and so on. Many organizations are looking at using carbon dashboards to monitor energy usage and efficiency of the supply chain, including the adoption of *Lean Six Sigma* methods and approaches. Second, there is the development, production, use, and disposal of hazardous materials and chemicals. This paper focuses on the latter, which includes recyclability and reduction of automotive waste, as the *green* challenge that is being explored.

It is estimated each year that ELVs generate between 8 and 9 million tons of waste in the community (from the EU and non-EU OEMs) that must be effectively managed. Some analysts suggest European OEMs will be responsible for recycling 200 million vehicles. In 1997, the European Commission adopted a proposal for a directive that targets making vehicle dismantling and recycling more environmentally friendly. It sets clear quantified targets for reuse, recycling and recovery of vehicles and for their components and forces producers to manufacture new vehicles to enable efficient recyclability. In European Union Directive 2000/53/EC, the EU set the following target dates for implementation:

- By 2002, certificate of destruction
- By 2003, ban on heavy metals
- By 2006, re-use and recovery of 85% of vehicles by weight
- By 2007, recovery free of charge for last owner
- By 2015, reuse and recovery of 95% of vehicles by weight

For more details about EU Directive 2000/53/EC, refer to the following Web address:

http://eur-lex.europa.eu/LexUriServ/site/en/consleg/2000/L/02000L0053-20050701-en.pdf

All automotive OEMs are publicizing their adoption of environmentally friendly methods, materials and processes to the extent that the environmental report of an OEM is often larger than its financial report. Most companies are significantly investing in programs, ranging from the operational efficiency of their own and suppliers' factories to investigating, through advanced research and development, how materials and fluids are most effectively processed. In addition, automakers must use as much recycled material as possible. Generally recycling centers are optimistic that the 2015 target for recovery is achievable, although currently the processes and approach to monitoring the achievement of this target are disconnected.

The OEMs firmly perceive that their responsibility for managing the ELV is when it arrives at a contracted dismantler. However, general concern exists over the reconciliation of OEM and dismantler processes and reporting. OEMs are developing recycling tools and procedures. Most include environment and recycling engineering representation in their integrated teams. OEMs are working extensively on materials production specifications to ensure compliance with company and legislative requirements and are mandating their use throughout the value chain.

Figure 1 illustrates an overview of the design, development, delivery, disposal, and recovery cycle of automotive components, assemblies, and systems.

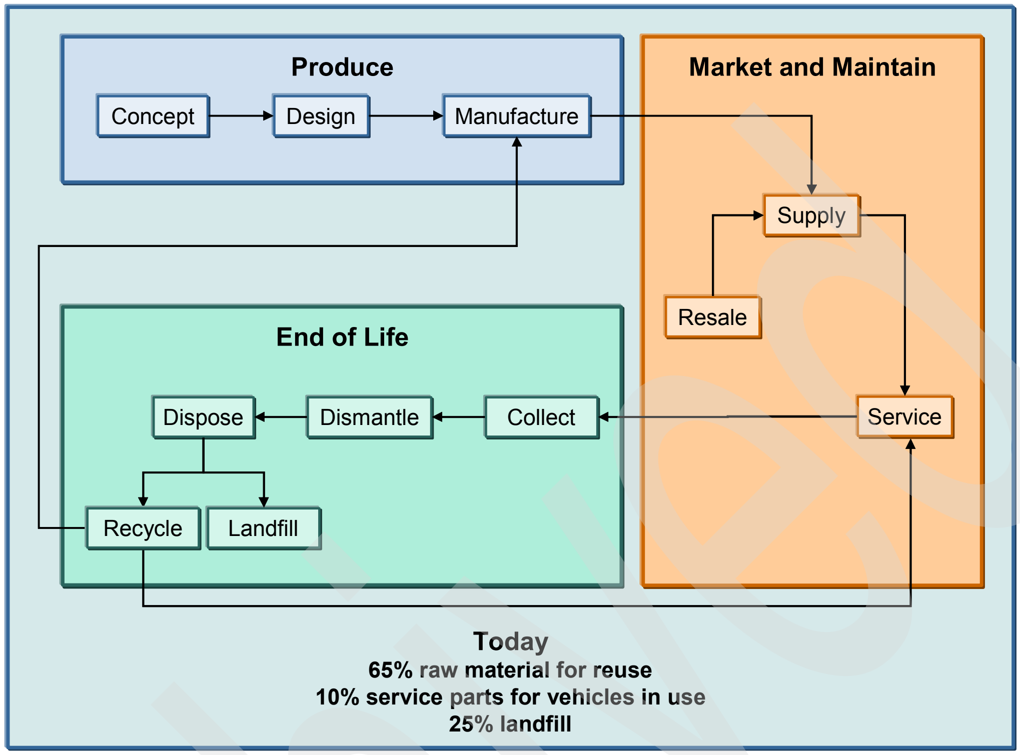

Figure 1 Design, development, delivery, disposal, and recovery cycle of automotive components, assemblies, and systems

Introduction to PLM, BPM, and BAM

This section introduces PLM and BPM with a focus on BAM, as a basis for looking at their associated technologies and application to our case study.

Product Lifecycle Management

PLM is a set of capabilities that enable an enterprise to effectively and efficiently innovate and manage its products and related services throughout the entire business life cycle, from conception through recycling or disposal.

To position PLM in the context of other parts of the business, consider the organization as being constructed from business controls such as customer relationship management (CRM), enterprise resource management (ERM), procurement, and value chain management (VCM). PLM is sub-divided into six further domains: sales and marketing, research and development, concept design, detail design, manufacture and assembly, and service after sales.

PLM enables innovation through business and technology integration by bringing people and processes together, both internally and throughout the value chain. Turning innovative ideas into market-leading products requires flexible business processes that are supported by integrated PLM solutions, all built on a strong technology foundation.

PLM brings together a vision of open enterprise integration platforms with design, data management, enterprise resource planning (ERP), supply chain management (SCM), customer management, manufacturing, and existing applications. PLM thus promotes flexibility to execute the dynamic processes that are needed to run a complex enterprise such as those seen in the automotive business. The requirement for openness is intensified by the need to operate as a globally integrated enterprise, which is typical within the automotive industry.

PLM solutions maximize customer value by enabling technology collaboration and integration across the value chain based on industry standards. IBM proactively supports PLM standards for the computing environment and uses technology such as J2EE™, Uniform Modeling Language (UML), Business Process Execution Language (BPEL), Web Services Description Language (WSDL), and the openness of Linux® and Open Source. In addition, IBM is a founding member of PDES Inc.,[1] which is an industrial consortium dedicated to the development and deployment of ISO standards for product data exchange (STEP).[2] IBM is actively involved in other standards organizations such as OASIS.[3] IBM plays a leading role in the PLM-specific open standards of STEP and Geometrical Dimensioning and Tolerancing (GD&T). PLM solutions can also use service-oriented architecture (SOA).

A good source for more information about PLM and SOA is Volker Klare's paper *Building an Adaptive PLM Environment Based on SOA*, which is available at the following Web address:

https://cpd-associates.com/download/index.cfm?download=Newsletter907I&company=

Ultimately, PLM enables the creation and management of intellectual capital, not only during the product design stages, but from idea creation through end of life. It enhances companies' development processes and their ability to use product information to make the best overall choices in selecting which product to make and how to make it.

Business process management

At the heart of every business and PLM is a complicated web of processes that form the foundation for all operations. These business processes are the lifeblood of the organization and typically include all humans and systems that exist within the enterprise. Since they play such a central role, business processes must be efficient to make the business as effective as possible. As a result, finding ways to automate and improve business processes has become a major focus for today's organizations as they struggle to find ways to become more agile and responsive to changing business climates.

An entire discipline, BPM has grown out of the desire to improve existing business processes and build new processes and services that will differentiate a business from its competitors. BPM software suites aim to provide enterprises with a common platform that can tap into all resources, both human and system based, to create, manage, and optimize effective business processes that span the enterprise.

BPM includes the following capabilities:

- *Modeling and simulation* enables visualization, comprehension, documentation, and analysis of business processes. IBM WebSphere® Business Modeler provides advanced process modelling and simulation capabilities.
- *Human interaction and collaboration* enables the sharing of process model designs with other stakeholders and subject matter experts for review, comment and feedback. IBM WebSphere Business Modeler Publishing Server provides these human interaction and collaboration capabilities.

[1] http://pdesinc.aticorp.org/
[2] *STEP Application Handbook ISO 10303 Version 3*, June 30, 2006, is available at the following address: http://pdesinc.aticorp.org/downloadable_files/STEPapplicationhandbook63006BF.pdf
[3] http://www.oasis-open.org/home/index.php

- *Business Process Automation* enables the implementation, deployment and governance of dynamic business processes. IBM WebSphere Process Server and IBM Business Services Fabric enable dynamic business process automation.
- *Monitoring, analyzing, and acting* enables monitoring of business processes in real time for visibility and insight into process performance and operational metrics to support continuous process improvement. IBM WebSphere Business Monitor brings these capabilities to market.

For more details about BPM enabled by SOA at IBM, refer to the following Web address:

http://www.ibm.com/software/info/bpmsoa/

Business activity monitoring

Business activity monitoring refers to the aggregation, analysis, and presentation of real-time, role-based information. It includes tracking performance, processes, and operational activity by using key performance indicators (KPIs) that are visualized on business dashboards. When working in conjunction with BPM, BAM also facilitates taking action, either by a business user or automated means, to proactively address current and potential issues that impact the business. As a result, business users can address problem areas quickly and reposition organizations to take full advantage of emerging opportunities. BAM and BPM position organizations to use marketplace or competitive changes almost instantaneously, without the lag time that can hinder companies in this global marketplace.[4]

The following key technologies are used in a BAM solution:

- Flexible data acquisition to make information available via events for monitoring
- Monitor models, which contain information about the BPM aspects of an entity to be monitored
- Web 2.0 business dashboards for business users to gain insight into the processes or information sources that are being monitored

Adopting BPM and BAM with PLM

The adoption of BPM initially provides organizations with a solid understanding of the efficiency and effectiveness of their business processes. It offers the ability to create and restructure process-driven applications and integrations. It also offers the means to tightly integrate the organization and value chain, but with the flexibility to rapidly change and adapt as circumstances require.

One simple aspect to consider is that PLM users often need to combine information stored within PLM applications with information stored in other enterprise applications. By using BPM enabled by the *Smart SOA*™ approach, users can access all product data, regardless of its location, through single sign-on (SSO), accurately and quickly. Perhaps most importantly, the adoption of BPM does not mean replacing existing PLM implementations.

The BPM approach is based on optimizing existing capabilities and creating new functionality, enabled by the services-oriented approach, to deliver dynamic processes and improved business automation and data quality. Success in BPM projects is maximized by using the expertise of experienced practitioners to deliver and fulfill the promise of BPM.

[4] Bill Gassman, "MarketScope for Business Activity Monitoring Platforms" Gartner Research, August 16, 2006: http://www.bammatrix.com/images/pdfs/Systarmarketscope_act_142011.pdf

BPM can be approached in many ways. In developing BPM content for PLM, organizations can start from any number of places depending on their type of project. Users can realize incremental benefits with their deployment of BPM or build out strategic BPM solutions.

BAM can be leveraged with BPM and PLM to enable real-time insight into end-to-end processes and mitigating and corrective action to be applied to key parts of the product life cycle. Also, actual business performance information can be used to optimize PLM processes.

In summary, PLM encompasses the management of all data and documentation relating to the idea creation, design, development, manufacture, production, delivery, and disposal of the vehicle. PLM can use BPM, enabled by the Smart SOA approach, for promoting integration and collaboration across the business and value chain, and BAM, which enables real-time insight, proactive corrective action, and process optimization.

For more details about the Smart SOA approach, refer to the following Web page:

http://www.ibm.com/software/solutions/soa/

Addressing environmental pressures on the automotive OEM

PLM is the core capability that manages the environmental footprint of the vehicle with processes such as materials management, product configuration management, release to manufacture, and change control. PLM defines what is delivered to the customer and ultimately manages it through the point of disposal.

Configuration management is the process by which the unique serialized and standard parts that are fitted on every vehicle are captured. The requirement is to track the configuration of the vehicle from "cradle to grave." This tracking includes the following stages:

- As-designed
- As-manufactured
- As-driven
- As-maintained
- As-disposed

The transition of configuration states is often captured on different applications. Through the application of BPM and SOA technologies, it becomes a secure and fully automated integration activity.

Every part on the vehicle is defined by a part number, description, and quantity used. To ease the tracking of the parts fitted to a vehicle from the time of manufacture to the point of recycling, many components are fitted with either a barcode or a radio frequency identification (RFID) tag. By using these approaches, in conjunction with integration between various lifecycle management applications, the value chain realizes process automation through step driven processes. This automation allows instantaneous identification and validation of the as-maintained configuration of the vehicle. Ultimately, all typical work tasks can be driven through process automation. Consider the following example:

1. A fitter logs on to a mobile device, in this case using a ruggedized PDA, at the start of the day and identifies prioritized work tasks.
2. Through integration of the processes and lifecycle management applications, the fitter retrieves all task supporting documentation.
3. The fitter captures the current configuration of the vehicle and sees any variance between the as-driven and as-maintained views.

4. The fitter identifies which parts need replacing, and by using a RFID or barcode, scans the part number for removal, which results in the updating of current vehicle configuration.
5. The fitter replaces the part and updates the as-maintained configuration.
6. The fitter reviews the information for the disposal procedure of the removed part (identified by its recyclability or nature of hazardous content) and report status of recycling or disposal into the ELV system.

BPM and BAM technologies can be applied to the PLM techniques just described. A number of business procedures are involved in the PLM for the automotive OEM. A first step in the path of applying BPM principles to addressing the environmental pressures on the automotive OEM is to assess the current state of the business processes. IBM WebSphere Business Modeler can be used to document and model these processes both from a business and implementation perspective. Standard process constructs that use Business Process Modeling Notation (BPMN) formats are used to capture the existing process logic and share the current state with others.

Future state process models may be built, with collaboration from business stakeholders, to identify process optimizations. The future state view can be derived from open standard Process Classification Frameworks (PCFs). Although this approach is not meant to be a quick solution, these PCFs are a great starting point for process improvement.

For more information about PCFs, refer to the APQC Web site at the following address:

http://www.apqc.org/portal/apqc/site

Process modeling can employ sophisticated simulation capabilities that allow technical business analysts to understand and apply *what if* scenarios to a simulated running process. This enables cost and efficiency of the processes to be understood and modified.

Technical implementation models can be built by using WebSphere Business Modeler. They can then be used to drive implementation of the processes by using workflow and process engine software, including incorporation of automated and human work services. Process implementation can be completed by using IBM WebSphere Integration Developer. The implemented processes can be deployed to workflow or process engine run times that provide a secure and robust implementation infrastructure, such as WebSphere Process Server. These techniques apply to both the realization of incremental gains from BPM and the building out of new processes and implementations.

While processes are executing, WebSphere Business Monitor can be used to allow business executives, process owners, and process operations personnel to achieve insight into a real-time process operational state. These personnel can also proactively address issues and anomalous situations, rather than wait until historical reports are generated. WebSphere Business Monitor can also be used in the optimization of the business processes. For example, if a recycling problem appears for a certain type of automotive material, manufacturing and recycle procedures for that material can be studied and potentially improved.

Benefits and use case of combining PLM, BPM, and BAM

The following scenario is an example of how the combination of BPM, BAM, and PLM can address environmental pressures on automotive OEMs.

Scenario overview

The ELV Creation and Destruction process is not a single specific process, but the collation of elements from many processes that are highly simplified. This process has the following objectives:

- Ensure that environmentally friendly materials are used in vehicle development.
- Ensure that, at disposal, the materials are appropriately dismantled.
- Ensure that the component parts and materials are reused and disposed of most effectively.

In addition, this scenario directs OEMs and suppliers to report back to the legislative authorities their achievement of environmental targets. If they are not compliant, they are fined appropriately.

> **Note:** The reference metrics, KPIs, KPI ranges, and target values that are used are illustrative in nature and are not meant to reflect actual true targets for the industry.

Five roles are involved with this use case:

- Supplier

  Organizations within the value chain who provide products or services in support of the development, delivery, manufacture, production, and after sales support of the vehicle. Suppliers typically have relationships with the following entities:

  - OEMs to whom they provide design intent, materials and parts
  - Recyclers from whom they may get parts to repair, rebuild and re-issue
  - Legislative bodies to whom they must give an account of their achievement of environmental targets

- Customer

  The user of the vehicle who may or may not be the original purchaser. The customer requires vehicle availability. Therefore, they interface with the OEM (or representatives in the form of local dealers) or third parties for service. Ultimately the customer is likely to dispose of the vehicle either naturally at the end of the vehicle’s life (about 10 years) or prematurely for unnatural reasons such as accident, flood, fire, or vandalism.

- OEM

  The organization with ultimate responsibility for development and delivery of the vehicle and providing proof of compliance to environmental legislation. The OEM maintains relationships with all participants with the following parties:

  - Suppliers to ensure timely delivery of components
  - Customer to ensure that the vehicle delivered to market is appropriate for requirements and to help the customer with their purchasing decision
  - Recycler to ensure full traceability in the configuration of the vehicle from manufacture to disposal and for feedback on recycling and reuse volumes
  - Legislative bodies to report against environmental targets

- Recycler

  Responsible for the receipt of vehicles that are ready for disposal and for dismantling them into component parts, assemblies, or systems that are ready for recycling or disposal.

- Legislative bodies

  Organizations empowered to fine OEMs and suppliers if compliance threshold levels are not met or demonstrated. Have relationships with OEMs and suppliers to receive, review and act accordingly in line with the reported level of attainment versus environmental targets.

Use case details

The preconditions for this scenario include a set of known and agreed to key performance indicators between the participants that can be set, monitored, and reported upon with minimal effort. In addition, participants must have the ability to track and trace all hazardous or environmentally impacting materials or components on the vehicle.

The lifecycle management applications and processes should be integrated and monitored for continuous improvement. Typically, this is a process that runs from a few days to up to two or three decades if the vehicle is appropriately maintained, although a 10-year life cycle is expected more typically.

The processes and applications must adapt to and adopt the evolving tools and techniques. The participants must put plans in place to ensure that data consistency and integrity are maintained through the life of the vehicle. This scenario is considered a success if the environmental targets (which are likely to change through time) are achieved by the OEM, and the legislative bodies do not impose fines as a result of failing to meet or demonstrating compliance.

To support the management and demonstration of compliance, the OEM creates business measures within the processes that can be monitored and that can send alerts to appropriate roles within the organization if thresholds are breached. These business measures require monitoring of every vehicle in service, although the reality is that user insight is likely to be aggregated at region, country, batch, or a combination of these three criteria. To enable this monitoring, every vehicle configuration is *activated* as soon as it is released for sales. As such, the vehicle date in service, the as-delivered bill of materials, and vehicle identification number are the three key parameters against which the environmental business measures are associated.

The following real processes are some of those that feed into the ELV Creation and Destruction process:

- Product assembly
- Receive vehicle
- Maintain vehicle and update configuration
- Recycle and dispose

Case study

The application of technologies is illustrated by using the following case study.

Process modeling, simulation and deployment

By using WebSphere Business Modeler, the ELV Creation and Destruction process has been documented as a representative summary of the use case, as shown in Figure 2. The actual execution processes that are deployed to process and workflow run times can also be modeled and simulated. IBM WebSphere Business Modeler Publishing Server can be used to allow business user collaboration on the process models by managing review cycles for the processes. An option for process deployment is WebSphere Process Server. IT personnel can use WebSphere Integration Developer to complete the implementation processes and applications for deployment to WebSphere Process Server.

Because actual process information is tracked with WebSphere Business Monitor, the information can feed back into the WebSphere Business Modeler and be used for continuous process improvement.

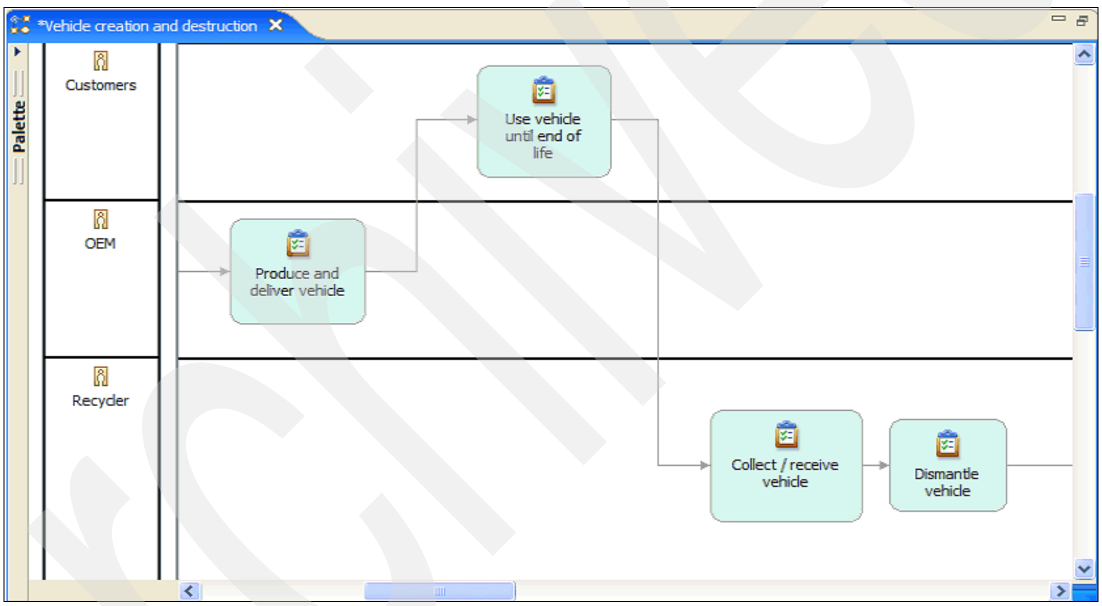

Figure 2 Partial ELV Creation and Destruction process

Figure 3 describes a high level system level architecture. The high level ELV Creation and Destruction process encompasses portions of many of the underlying applications and processes.

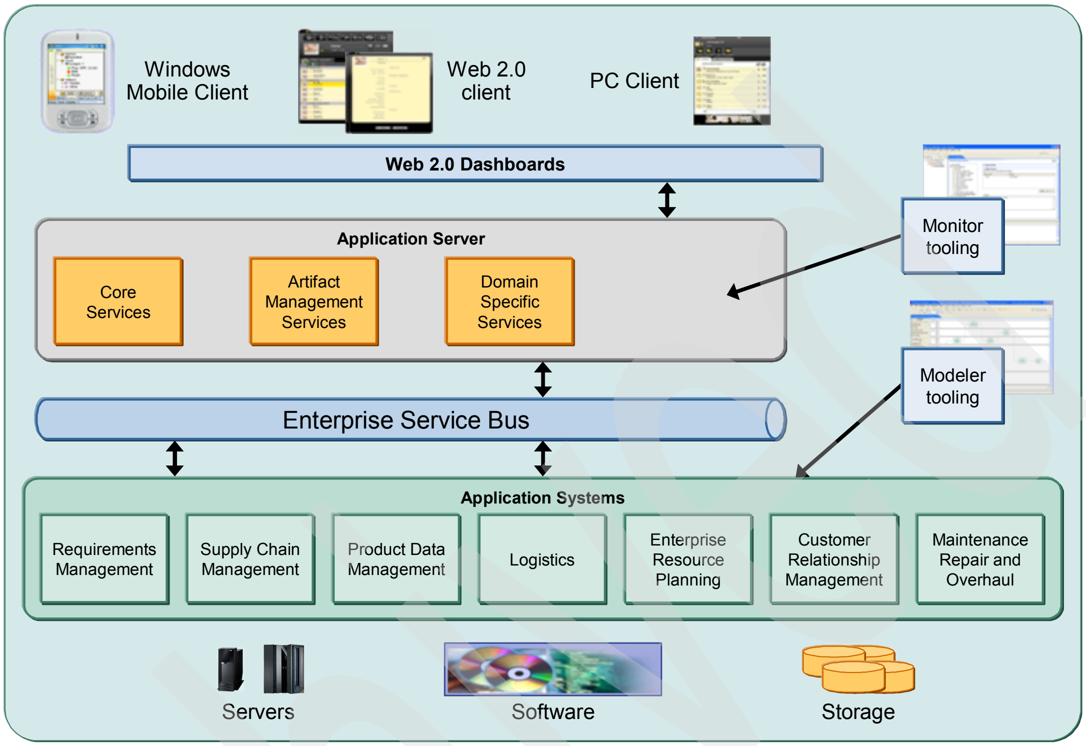

Figure 3 System architecture

Business activity monitoring

WebSphere Business Monitor uses information that is supplied at run time from the deployed processes and applications that underpin the high level ELV Creation and Destruction process. IT personnel define instance metrics for the monitored process, events, KPIs, real-time situations to be triggered, and dimensional structure to support historical analysis. WebSphere Business Modeler can optionally be used to define some of this information, thus enabling management of the monitoring requirements at the business level.

Process instances are represented by an individual vehicle that traverses the vehicle life cycle, from manufacture to dealer and customer delivery, to delivery to the recycler and dismantle or recycle. At the process instance level, the following metrics are tracked:

- Vehicle Identification Number (VIN), the key for the process instance
- Date that each lifecycle stage occurs
- Dealer ID
- Country code where the vehicle is registered
- Recycler ID
- Quantity information for each tracked material contained in the vehicle

Materials are likely to be categorized by type. In this scenario for simplicity, the defined categories are plastics, carpet, and glass. By using information provided at each lifecycle stage, the amount of each material that is lost, recycled, or thrown away throughout the process is captured and tracked. Thus recycle effectiveness against defined targets can be shown. For this scenario, we assume that the manufacturing and recycle processes can report to the solution information about the weight/volume of each material of interest in the vehicle, as well as other information needed for tracking including the VIN, date, dealer ID, and recycler ID.

The information about the as-manufactured vehicle material quantities is likely obtained from a static database, rather than carried with each vehicle instance. The source information is obtained from the manufacturer and loaded into the static database. WebSphere Business Monitor can access this information in real time when calculating process metrics and KPIs. Both this static information and data collected from various applications at points in the process can participate in the BAM solution.

KPIs are derived from process instance metrics and from other KPIs. The participating roles need insight into the following KPIs, among others:

- Average years of service for vehicles broken down by vehicle make, model, and country
- Current effectiveness of recycling efforts for each material category broken down by recycler
- Recycling effectiveness for each recycler

For purposes of this scenario, the following KPIs are used:

- Average dismantle or recycle duration
- Total average percentage of vehicle materials recycled, which is broken down by the following categories:
  - Carpet
  - Plastics
  - Glass
- Total vehicles in service
- Vehicles in service in France, Germany, and Sweden

In addition, there are many situations where participants might want real-time alerts. This scenario uses a situation that consists of triggering an alert when the average recycling percentage for plastics category for this month drops below 10% of the target of 65%.

Business dashboards

Typically each role identified in the scenario description has its own set of business dashboards that address their needs for insight into the process. Figure 4 gives insight into the effectiveness of recycling efforts. It also provides details about situations and specific recycle instances that may need to be investigated (depicted by using WebSphere Business Monitor).

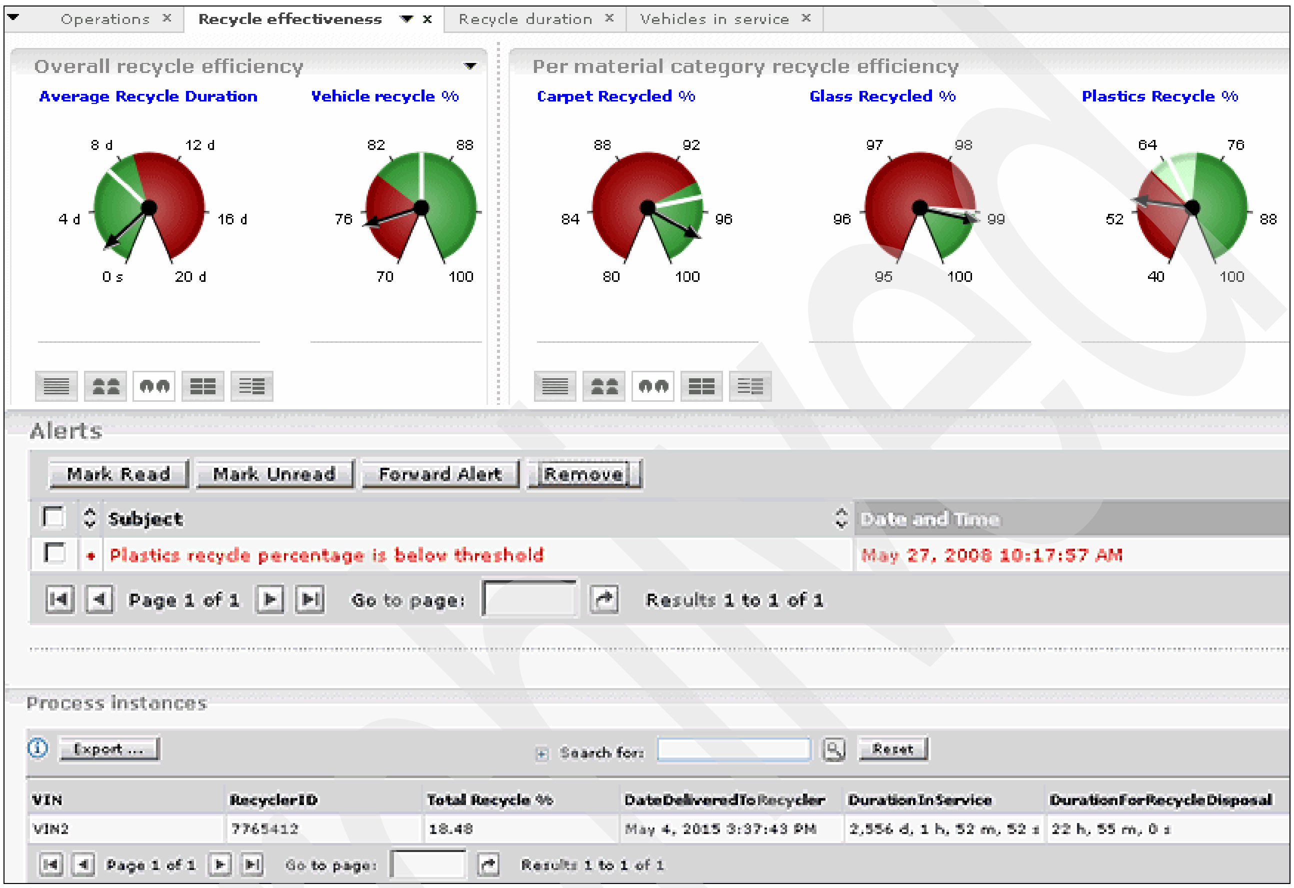

Figure 4 Recycle effectiveness

The top left pane (in Figure 4) shows the average recycle duration in days and the average percentage of the vehicles recycled. In this case, averages are shown for the current month. This KPI can be configured to show different time ranges and rolling time ranges. The target recycle duration in this scenario is seven days, and the target percentage for vehicle materials recycled is 85%. In this illustration, the current Average Recycle Duration is in the *good* range, and the Vehicle recycle percent is in the *poor* range.

The top right pane breaks down the average category recycle percentages for different types of materials. For this illustration, averages are for the current month. The Plastics Recycle percent is below the target of 65%.

The Alerts pane (bottom portion of Figure 4) displays alerts of interest. In this case, there is an alert for the plastics category recycle percentage being more than 10% below the target threshold. The Process Instances pane displays individual vehicle lifecycle instances of interest. Since there is a huge volume of vehicle instances, this view is filtered to only show instances of special concern for the user. For example, anomalous instances for the region managed by this user for today are shown, or instances are shown that are related to certain recyclers that the user is responsible for tracking.

Figure 5 shows information about total vehicles in service and vehicles in service by selected regions. The values are an illustrative representation and may not reflect the actual numbers.

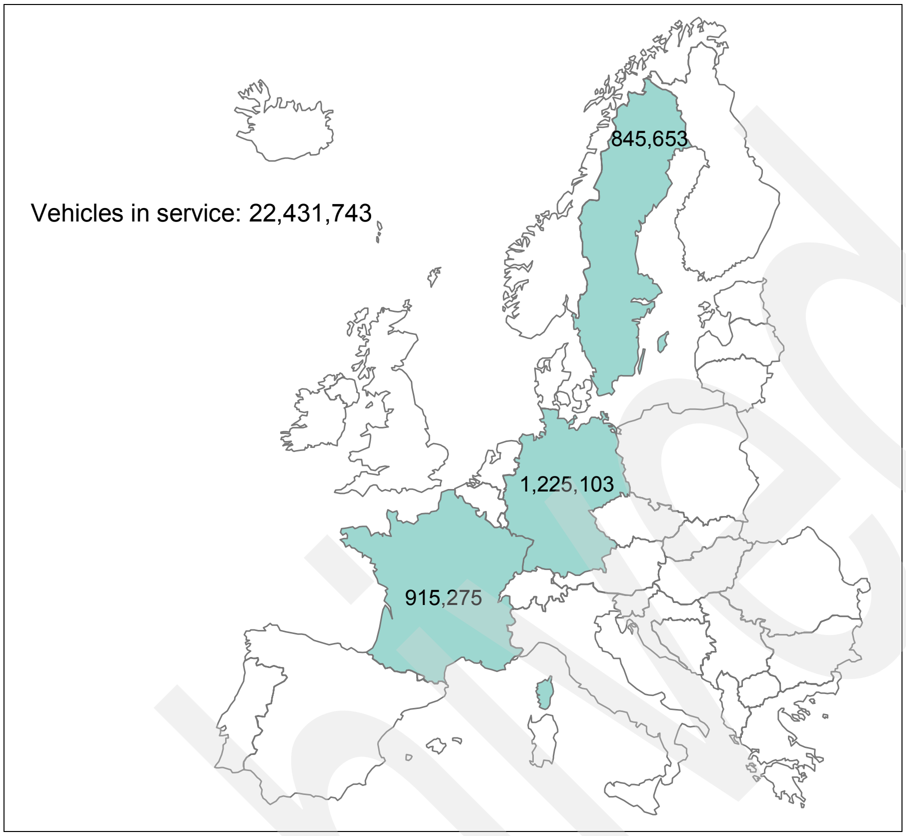

Figure 5 Vehicles in service summary

Figure 6 on page 17 shows how different recyclers are faring with respect to vehicle recycle effectiveness, across all material types. Each material type value can be further navigated to see recycler effectiveness for each type of material. In this case, the business user might want to assess recycler 120PLU7's procedures. However, all recyclers are below target. Therefore, there might be general issues to explore that are impacting recycle effectiveness.

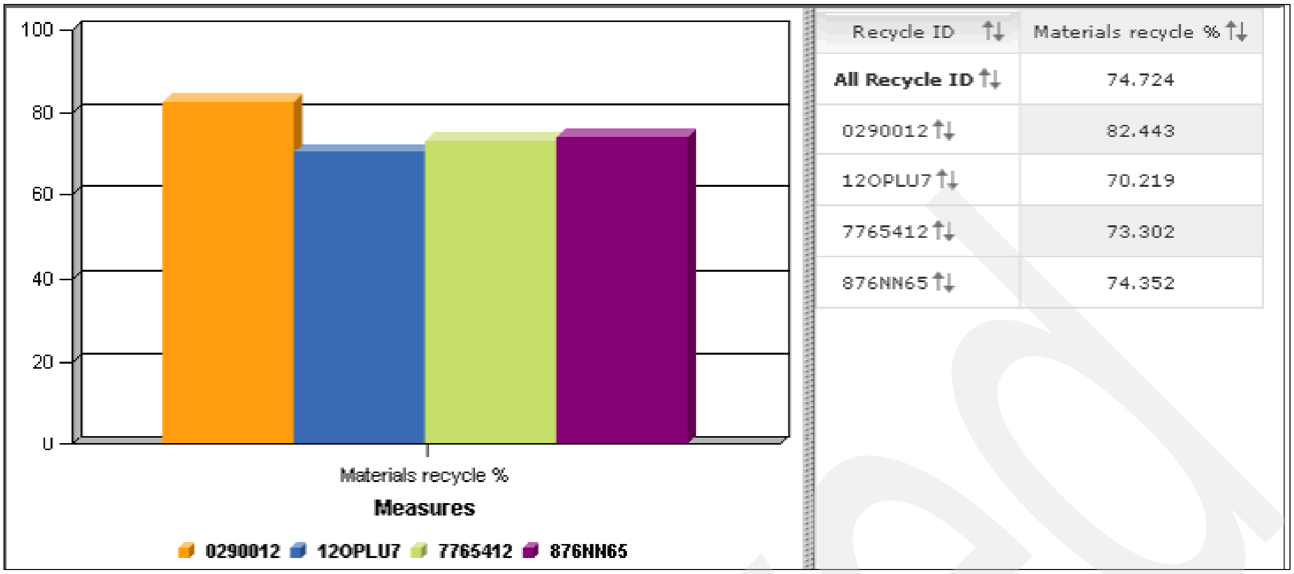

Figure 6 View for business user responsible for tracking a set of recyclers to assess recycle effectiveness by recycler ID

Feedback of actual process data into the modeling

The business operations insight in this scenario illustrates a number of factors that can feed back into the process definitions and be used to help achieve continuous process improvement. For example, the plastics category is not achieving its target for recycling. Therefore, the business may want to explore whether adjustments need to be made in the manufacturing process to enable better recycling rates and work with the recyclers who have the most trouble with plastics to see if processes can be improved.

WebSphere Business Monitor real-time data can be taken and brought directly into WebSphere Business Modeler and used in model simulations, to facilitate process understanding and improvement.

Conclusion

This paper illustrated the benefits that PLM and BPM, which includes BAM methods and technologies, offer to address the environmental challenges involved in the automotive industry ELV processes that automotive OEMs, both in Europe and worldwide, face as a result of EU directives.

As discussed by illustrating the vehicle creation and destruction process, the use of business process modeling, PLM processes and infrastructure, and BAM allows OEMs and other process stakeholders to implement processes and track key factors. An example includes the modeling of vehicle creation and destruction processes, the aggregation of data from several applications involved in the processes, the calculation of various process metrics and key performance indicators, and the tracking of these processes by using business dashboards to highlight the effectiveness of vehicle recycling efforts.

When these methods and technologies are applied, they can lead to improved OEM legislative compliance, improved reporting to legislative bodies, opportunity and insight for continuous process improvement, and better communication across OEMs and suppliers. Ultimately, these methods result in OEM cost savings related to all of these areas.

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