Deloitte.

Data-driven Process Optimization with Process Mining

In the Aviation Industry

MAKING AN IMPACT THAT MATTERS since 1845

Why process mining is worth the investment and how to get the most out of it 5

1. Process mining 5

2. Key trends and challenges in today's aviation industry 8

3. Solutions based on process mining 10

4. How Deloitte integrates process mining in its consulting practice 10

5. Future outlook 12

6. Summary 13

Contacts 24

2

Why process mining is worth the investment and how to get the most out of it

For aviation enthusiasts and people passionate about improving operational efficiency, this paper offers an ingenious methodology that promises to transform this industry: process mining. We live in a dynamic world with changing customer expectations, economic instability from geopolitical unrest, resource scarcity and volatility as well as climate change. Faced with these and other underlying factors, companies need to improve their operational excellence, focus on sustainable operations and make cost-cutting a top priority. Data-driven process mining is the ideal approach to rise to these challenges in aviation and logistics as well as countless other industries where complexities and interdependencies define day-to-day operations. In this paper, we will walk you through the ways data and process science can unlock synergies and overcome key aviation industry challenges. You will also learn how process mining technology can adapt to the post-pandemic landscape, meet customer service demands and break free from cost constraints. And finally, we will outline new features in the process mining pipeline, from artificial intelligence and machine learning to object-centric process mining. Get ready to improve, transform and reinvent your business processes and operations with Deloitte's proven data-driven strategies, joining other global airlines leveraging this technology in impactful ways across multiple business areas and use cases.

1. Process mining

Referred to as "data science in action" by the great pioneer in this field Prof. Wil van der Aalst, process mining offers "comprehensive sets of tools to provide fact-based insights and to support process improvements".[1] It connects data science with process science, merging the event data generated by modern IT systems with advanced process models.[2] We use today's process mining applications for process discovery, analysis and modeling, for conformance checking (actual vs. target process) and finally for business process optimization. Much like an x-ray for business procedures, process mining gives companies an objective view of exactly what is going on in their approach landscape.

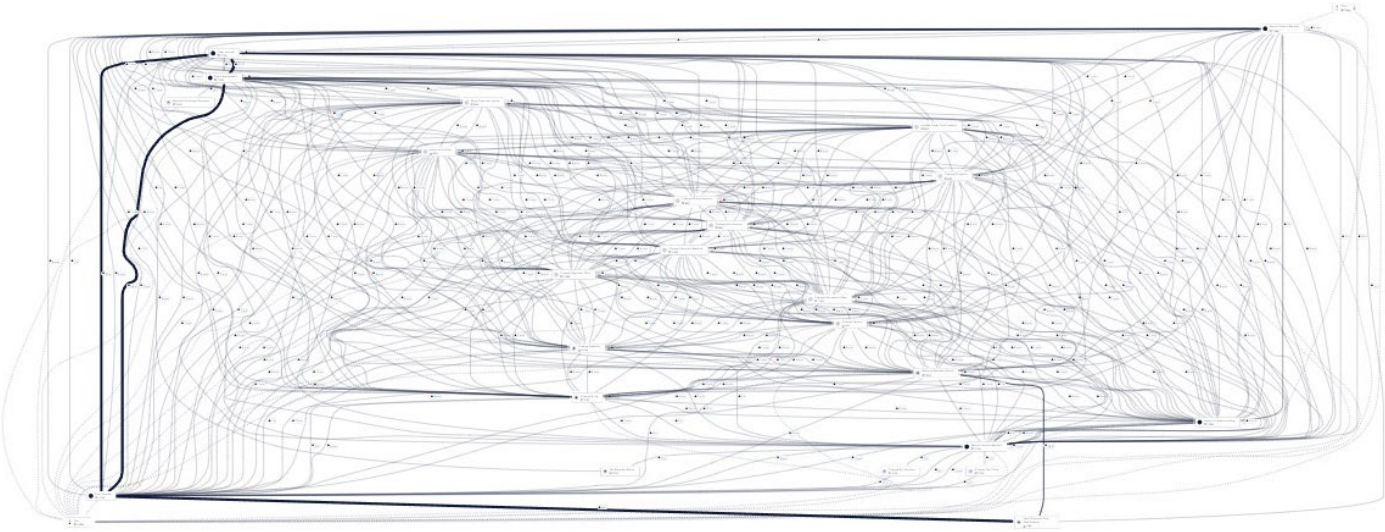
There are three main components that allow conventional process mining tools to extract valuable insights from company data: the case ID (e.g., a unique purchase order identifier), the activity (a process step, e.g., "create PO") and the time stamp (when the activity took place). The event log, which comprises several of these three-part entries, contains more detailed information as well as extractions (data tables) from one or more source systems (e.g., ERP or SCM systems). In essence, this data creates a digital footprint or so-called "digital twin" of a specific process such as accounts payable (AP). Process mining intelligence can then use this data as the basis for further insights.

Each event corresponds to an item on its way through a particular process variant, for example a purchase order (PO) processed with purchase-to-pay (P2P). The sum of these process variants forms the existing process landscape of a specific process. In addition to the main target process (the so-called happy path), process mining applications can visualize every other process variant, both those that operate as envisioned and those that do not. The latter is generally the starting point for deeper analyses and optimization efforts.

[1] van der Aalst, Wil, "Process Mining in Action", Springer Verlag, 2016, p. vii.
[2] van der Aalst, Wil, "Process Mining in Action", Springer Verlag, 2016, p. 17, 44.

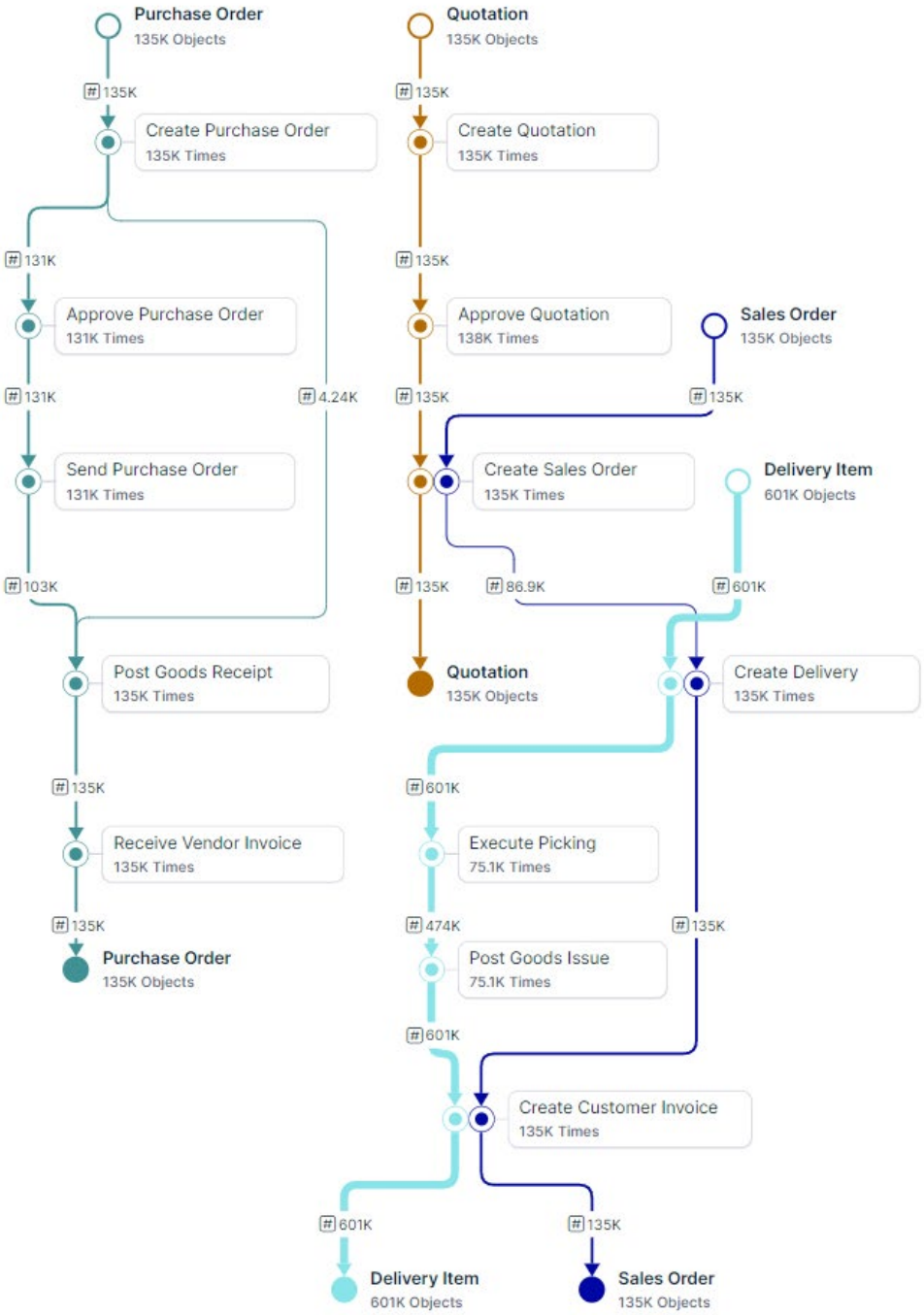
Traditional (case-centric) process mining focuses on the detailed analysis of a single process, while the networked approach of next-generation applications (e.g., P2P combined with AP) allows for more comprehensive mapping. In addition to analyzing a PO (item) that is issued and processed within the P2P process, you can now also track the corresponding invoice that is triggered and processed on the AP side. This advanced analysis, known as object-centric process mining (OCPM), allows you to map a single event to multiple objects, i.e., not only to its purchase order, but also to its invoice, production order, etc. The advantages of OCPM are obvious: You can visualize, analyze and optimize the interactions between objects and thus better illustrate the multidimensional reality.

Fig. 1 – So-called "spaghetti diagram" in Celonis, revealing all the actual process variants of a common business process



Thanks to its data-driven approach, process mining can help companies optimize complex and interrelated processes. This makes it predestined for the aviation and logistic industries, where complexity and interdependencies dominate day-to-day business. In the following chapters, we wil describe the key trends and challenges of today's aviation industry as well as our rec ommendations for viable solutions based on process mining.

Fig. 2 – A sample OCPM set-up displaying the interrelations and interactions of commercial core processes (P2P, AP, O2C, AR, etc.), highlighted in different colors[3]



[3] Graphic: Internal Deloitte Celonis Sandbox

2. Key trends and challenges in today's aviation industry

The airline industry has faced significant upheaval in recent years, primarily due to pandemic-driven changes in market structures and customer demands. An added factor is the Russia-Ukraine conflict, which has led to rising fuel costs and the rerouting of flights. Given these events, the general public and regulatory authorities have shifted their focus more to sustainability and urgent emission-reduction measures across all sectors. The airlines have responded by making operational efficiency and decarbonization top priorities, while investing in fuel-efficient aircraft and research in alternative fuels as key strategies to reduce greenhouse gas emissions. Their embrace of the green revolution is a direct response to government regulations and growing consumer demand for sustainable travel options. Industry players recognize that they must focus on technological advancements and improving supply chain resilience to remain competitive.

Operational efficiency – effective turnaround strategies to facilitate point-to-point operations with narrow-body aircraft

At almost 30% of total costs,[4] fuel accounts for a large proportion of an airline's operating costs. So even marginal improvements in fuel efficiency can significantly improve the bottom line. The use of high-tech fuel-efficient aircraft, the strategic selection of flight corridors and flight route optimization are all key ways to generate savings in flight. With better fuel efficiency and a longer range, narrow-body aircraft in particular are becoming more popular. This added flexibility suggests that the use of wide-body aircraft is on the decline while "narrow-body point-to-point operations" will increase.[5] Efficient turnarounds, driven by effective operational planning, will play a pivotal role here.[6] Crew management is another critical component, as efficient rostering, training and deployment of crew members will reduce overheads and improve service quality. Given the increasing emphasis on point-to-point operations, it is vital for crews to be optimally positioned and ready for quick turnarounds.[7]

Business model transformation – shifting the status quo to create opportunities for new business models

The aviation industry is moving towards low-cost carriers (LCCs), which use mainly narrow-body aircraft for their point-to-point services. Global LCC capacity rose from 27.5% in 2011 to 35.1% in 2020. In the US, LCCs, led by Southwest, had a market share of around 30%, while passenger traffic on European LCCs surged, accounting 43.7% of seats sold in 2020. Over half of global narrow-body orders come from LCCs. In addition to more traditional business models, the industry is embracing multimodality, mobility-as-a-service (MaaS) and other innovative travel models as well as regional air mobility (RAM), which relies on electric or hybrid aircraft and combines urban air transport with standard flights. Companies faced with this added operational and regulatory complexity will have to prioritize process efficiency and transparency to not only reduce costs with these business models but also ensure regulatory compliance and superior customer service.

Changing customer needs – decline in business travel

Airlines are struggling in face of business travels still being below pre-pandemic levels. While this is offset for some airline providers with air freight transport exceeding 2019 levels[8], companies are not only aware of the potential cost savings from less business travel and more virtual meetings; their customers also expect them to drastically reduce their carbon footprint in the coming years. Long-haul flights account for nearly 54% of carbon emissions in Europe but only roughly 9% of flights.[9] That means less frequent business travel reduces corporate travel expenses as well as avoidable carbon emissions. This evolving landscape is impacting revenue streams, especially for network airlines that have traditionally relied on business travelers to cross-subsidize economy fares. The industry is now shifting to fuel-efficient, single-aisle aircraft and focusing more on intra-regional travel. This poses challenges for full-service airlines, particularly European network airlines, as competition from low-cost carriers heats up. Given that smaller aircraft can service a broader range of city routes, this trend is also likely to benefit regional airports as well.[10]

Technology transformation – ongoing demand for more transparency, visibility and flexibility

Innovative technology has always been the key to change and progress in the aviation industry, but the focus is shifting. In an effort to keep adapting to changing customer demands, meet growth forecasts and comply with regulatory requirements, airlines and aviation players have to upgrade their largely outdated legacy systems to modern alternatives. Part of this transformation involves integrating and leveraging new disruptive technologies as growth drivers and the key high-tech building blocks for the future. In terms of core technology, airlines have to embrace changes ranging from moving their basic infrastructure to a multi-cloud solution and modernizing the mainframe to integrating AI and advanced analytics.

Today's aviation companies have access to a wealth of data, and it is vital to adopt a

[4] IATA, "Industry Statistics June 2023", accessed 3.11.23, https://www.iata.org/en/iata-repository/pressroom/fact-sheets/industry-statistics/.
[5] CAPA, "The six Megatrends shaping the aviation industry in 2022", CAPA Airline Leader Summit, p. 7.
[6] IATA, IATA Ground Operations Manual (2015), accessed 3.11.23, https://lms.butterfly-training.fr/media/FR/documents/docs/AHMIGOM-4th-Edition-2015.pdf.
[7] Boeing, "Commercial Market Outlook 2023-2042", accessed 3.11.23, https://www.boeing.com/commercial/market/commercial-market-outlook/index.page.
[8] Statista, "Statistiken zu den Auswirkungen des Coronavirus auf die Luftfahrt", accessed 20.11.23, https://de.statista.com/themen/6257/coronavirus-und-luftfahrt/#topicOverview.
[9] EUROCONTROL, "Think-Paper #21", accessed 3.11.23, https://www.eurocontrol.int/sites/default/files/2023-08/eurocontrol-think-paper-21-long-haul-decarb.pdf.
[10] CAPA, "The six megatrends shaping the aviation industry in 2022", CAPA Airline Leader Summit.

strategy that will leverage this data through advanced data analytics, AI, process mining and process simulation. Reducing operational inefficiencies, making data and processes more transparent and improving existing core business modules will not only increase profitability but also improve the end-to-end customer experience.[11] The promise of a seamless, transparent and efficient customer journey is a major selling-point for customers – especially in the airline industry.[12]

Sustainability revolution – navigating aviation's green transformation

Sustainability is no longer a "nice-to-have" for the aviation sector; it is a "must-have". The ability to anticipate regulatory, societal and technological changes is an essential element that the industry can no longer afford to ignore. The pressure to reduce carbon emissions and embrace sustainable practices is growing, with the aviation industry under scrutiny for its environmental impact. Sustainable aviation fuel (SAF) is one of the key measures to reduce aviation emissions.[13] Airlines investing in SAFs and sustainable technologies will be better positioned to weather the green technology disruption that lies ahead. However, sustainability in aviation extends beyond simply reducing emissions; aviation customer expectations are growing as well. Passengers are now demanding more flexibility in ticketing, instant refunds, superior service and a seamless online and in-flight experience in addition to emission reductions.[14] Airlines must innovate to provide both eco-friendly services and a premium customer experience. Optimization practices such as process mining and simulation can shed light on inefficiencies in various areas of operation,[15] from fuel logistics to flight scheduling and ground handling. With these methods, aviation players can streamline the identified areas and promote their leaner, more environmentally-friendly practices. In the following we show you real-world examples, that have already been implemented as various use cases in the aviation industry.

[11] Deloitte, "2023 Airline Tech Trends: Retooling to take flight: Technology trends in the airline industry", accessed 3.11.23, https://www2.deloitte.com/content/dam/Deloitte/us/Documents/consumer-business/airline-tech-trends-2023.pdf.
[12] IATA, "2022 Global Passenger Survey", accessed 3.11.23, https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf.
[13] CAPA, "The six megatrends shaping the aviation industry in 2022", CAPA Airline Leader Summit.
[14] IATA, "2022 Global Passenger Survey", accessed 3.11.23, https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf.
[15] IEEE, "International Conference on ICT and Knowledge Engineering", accessed 3.11.23, https://dx.doi.org/10.1109/ICTKE55848.2022.9983203.

3. Solutions based on process mining

The key challenges and trends outlined in the previous section have generated serious demand for a transformative approach focused on efficiency and scalability, and process mining can be an effective solution. A recent Deloitte project at a leading German airline focused on operational productivity, starting with an analysis of the current state of the client's customer complaint process. One of the project deliverables was setting up a comprehensive dashboard (in Celonis) with the most business-critical KPIs and their historical trends (actual) before moving on to identify and validate where there was potential for added value. Finally, the optimization potential was converted into concrete metrics for the desired future state (target). Two of the most business-critical outcomes were the significant reduction in processing time per claim and the optimization of supplier management through data-driven monitoring of SLA compliance. The client was also able to substantially reduce the amount of time spent manually reworking claims. As a technology and an ideal add-on for Deloitte's assumption-based planning approach, process mining provided end-to-end process transparency as a key enabler for making correlations and validating the overall business case.

In addition to the examples mentioned above, Deloitte has the expertise to support your enterprise with many other use cases and effective solutions.

Some examples of value cases:

- **Crew planning and rostering:** There are many challenges associated with crew management, whether it is changed or delayed flights/routes, sub-optimal work-life balance or staff shortages. Solution: use process mining to design the ideal processes and communication strategies, including automation and simulation, in order to improve crew and customer satisfaction.
- **Turnaround optimization:** To ensure customer satisfaction and operational efficiency, airlines need to improve on-time departure and arrival, manage idle time and reduce total provider costs per flight. Solution: improve ground staff management by predicting and avoiding delays through the clearing and analysis of delay codes, identifying hidden SLA deficits and monitoring provider performance to prevent suboptimal turnaround planning and costs.
- **Finance transformation:** Companies need to manage the two key financial drivers: working capital and costs as effectively as possible. Solution: Setting up automatic alerts to avoid late payments and avail of early payment discounts are both good strategies for optimizing cash flow. Automation means fewer manual interventions for each invoice, which reduces the costs for each purchase order and facilitates maverick buying thanks to end-to-end transparency.
- **Technical operations & MRO management:** It is important to optimize the strategic management and planning of maintenance and material logistics. Solution: Leveraging real-time information, airlines can cut costs by optimizing their aircraft on ground (AOG) orders, for example, and by avoiding material movements or scheduled maintenance that are not needed.

These examples show the huge business potential of process mining technology, regardless of the industry or business area. As a fully process and industry-agnostic technology, there is no end to the use cases (problem/root cause/solution) you can develop with process mining. There are opportunities to leverage this technology across the entire process landscape in aviation, whether it is ground, flight or technical operations, maintenance and material planning, or core business areas like accounting, finance and HR, to name just a few of the areas that promise fast ROI and scalable business potential.

4. How Deloitte integrates process mining in its consulting practice

As one of the leading consulting firms in the field of technology-driven business transformation, Deloitte uses state-of-the-art tools such as process mining to deliver real value to clients in the shortest possible time. The main way Deloitte adds value is through its profound industry and process expertise in transportation and logistics services. This knowledge is critical for the success of corporate transformations based on process mining. After all, in order to identify significant process correlations, the business impact of any deviations and their implications for business-relevant KPIs and process fidelity, you need an explicit and validated interpretation of your most critical core processes – which would not be possible without the transparency generated with process mining.

So, Deloitte established an integrative consulting and delivery approach that starts with a readiness assessment made up of the following key elements:

0. Readiness assessment: ensuring that the client has the necessary technical and data-related infrastructure in place and that the process mining technology is ready to use

I. Problem statement: summary of the target state based on the current process design and associated challenges

II. Definition of use cases: collection and prioritization of use cases based on value potential as well as expected effort (impact/effort matrix)

III. End-to-end implementation: construction of the data model followed by front-end analysis (dashboards) in the client's IT and system landscape (standard, proprietary or homegrown)

IV. Process transformation: identification of the future process design based on the originally specified KPIs and target state defined in step 1

V. Continuous monitoring and improvement: systematic training of relevant stakeholders to enable independent use, continuous monitoring of KPI trends and creation of a strategic use case pipeline to continue adding value

On the operational side, Deloitte's most recent process optimization projects based on process mining developed a "hybrid" consulting approach that combines a hypotheses-based method with process mining technology. The outcomes have all been quantified, fully validated and are sustainable for our clients with a significantly shorter time-to-value.

Thanks to its matrix structure, Deloitte can draw on the profound data engineering expertise of the "Center for Process Bionics", a Center of Excellence and internal hub for various state-of-the-art technologies with a successful track record in numerous client projects and a completely hands-on mentality.

Thanks to our constant pursuit of successful technical implementations, we can help you optimize specific and critical business processes as well as end-to-end transformation initiatives just when you need them. After all, process mining technology combined with deep industry and process expertise has the potential to dramatically impact your future process design. There are, however, certain fundamental requirements that necessitate careful consideration to unlock this potential.

We have outlined some of these success factors in the following

From problem statement to solution

An effective process mining solution requires a comprehensive understanding of the client's business challenges, so that we can focus on use cases with the highest value potential for the least effort (impact/effort matrix). At Deloitte, this critical phase known as "Identify" consists of dedicated workshop(s) with the client and his relevant stakeholders, which we will describe in more detail in the next paragraph. The term use case defines the specific problem and its root cause as well as the proposed solution. These insights enable us to formulate an achievable target state with measurable KPIs and aligned expectations regarding the project outcome and desired improvements.

360° involvement of relevant stakeholders

Management decisions and "top-down" approaches may lead to effective implementations, but they are not generally sustainable or effective in the long term. Identifying the strategic data-driven process optimization initiatives with a lasting impact takes commitment, conviction and strategic focus on the part of stakeholders who are either driving those initiatives or significantly affected by them. Process owners, business owners, IT staff and team members are relevant stakeholders you need to involve, empower and engage as part of the vision behind your strategy. We recommend building centers of excellence and integrating process mining into these in-house centralized resources to increase stakeholder buy-in, ensure effective maintenance and deliver real business value.

Clear distinction between analysis and improvement

The initial "Identify" phase mentioned above provides a clear understanding of the project's purpose and objective. It is vital to distinguish between an "Analysis" project, which creates end-to-end process transparency in order to identify measures to take your processes from the actual to the desired target state, and an "Improvement" project. The latter focuses on transforming processes using additional functionality such as automation, intelligent alerts or process conformance checks. "Analysis", by contrast, is generally the initial kick-off phase for our clients, who tend to be very impressed with the objective overview of their current process landscape generated with process mining. The best way to gain these insights is through a "Pilot" phase, which Deloitte usually delivers in less than six weeks through a data-dump and compelling visualization of the most relevant KPIs on the dashboard. Alternatively, we can include "Improvement" initiatives as part of existing process optimization plans or initiatives, as they support them with powerful insights from process mining and enhanced features such as automation, intelligent alerts, conformance checks or simulation of different case scenarios. After reflecting the implementation phases and success factors for process mining, we would like to give a future outlook with the latest developments in process optimization.

5. Future outlook

Increasing adoption and integration in business processes

Looking at a broader perspective beyond the horizon of the aviation industry and its challenges, all industries have one thing in common – the gradual adoption of process mining technology to help improve operational efficiency, reduce costs and enhance customer satisfaction. We expect to see rapid growth in the adoption of process mining tools and techniques for the following reasons:

1. Increasing demand for operational excellence: Companies across all sectors are embracing business process optimization initiatives to achieve operational excellence. Process mining provides actionable insights into process inefficiencies, which is driving demand for process mining solutions.

2. Regulatory compliance: Due to regulations such as GDPR, companies need an objective overview of their processes and the right technology to ensure data privacy and security. Process mining can help companies comply with regulations by bringing transparency to their processes and identifying potential risks.

3. Digital transformation initiatives: As companies set out on their digital transformation journey, process mining can be a critical tool when it comes to identifying opportunities for process automation, improving customer experience and streamlining operations.

Simulations and forecasts based on real-time process information

Process mining continues to evolve with new forecasting and simulation features that enable companies to obtain deeper insights and make more informed decisions about their processes. By leveraging historical data, the simulations and forecasts generated by process mining tools help you optimize process performance, identify potential bottlenecks and predict future outcomes.[16]

When you enhance simulation and forecasting activities with process mining insights, you can test different scenarios and process variants without making changes in the real-world environment. Modifying resource allocation, workload distribution, decision rules and other parameters empowers you to simulate the impact of potential changes and evaluate their effectiveness before full-scale implementation. You can make more proactive decisions as a result, evaluating the impact of different optimization strategies before choosing the most effective one. This helps you align process optimization efforts with your broader strategic objectives, identify potential issues or risks in advance and make data-driven decisions to improve process efficiency.

Object-centric process mining (OCPM)

OCPM is a novel approach that focuses on analyzing processes based on objects rather than activities and therefore provides a more detailed understanding of the value chain as a whole.[17] With a better understanding of the way objects interact within a process, you can uncover hidden insights and further optimize your processes. The benefits of OCPM include improved process transparency for a deeper understanding of the way processes actually operate, better process performance due to the focus on object-centric bottlenecks, inefficiencies and deviations, and more contextual insights into which objects are actually being used.

[16] Celonis, accessed on 26.10.23, https://www.celonis.com/blog/simulation-analysis-in-process-mining-definition-applications-and-techniques/.
[17] Celonis, accessed on 26.10.23, https://www.celonis.com/blog/what-is-object-centric-process-mining-ocpm/.

6. Summary

In conclusion, process mining is a powerful methodology that combines data science and process science to give users the power to validate and interpret data. It has been tried and tested in a wide range of business processes, helping to gain insights, build analytical models, ensure compliance and optimize business processes. With its event-driven approach, you can track processes across different objects and make intricate, interactive procedures more transparent. We have seen process mining become considerably more prominent in sectors such as aviation, as it provides solutions to make approaches more efficient and overcome enormous challenges.

The aviation industry is facing numerous challenges, including the volatility of the post-pandemic era, growing customer expectations and the imperative of cost savings. Process mining can help aviation players find solutions and develop new strategies, whether that is improving operational efficiency and sustainability efforts, managing staff shortages or solving supply bottlenecks in the areas of aircraft acquisition as well as maintenance, repair and overhaul.

Looking to the future, demand is expected to increase for process mining and new functionality using artificial intelligence (AI), machine learning (ML) and automation as well as other technologies. We also believe features such as real-time process monitoring and simulation will become increasingly important. Predictive analysis enables companies to optimize their processes, identify bottlenecks and predict future outcomes. And with a more detailed analysis of interactions between the objects of a specific process, object-centric process mining (OCPM) will unlock further opportunities for optimization and process excellence.

Contacts

Tilmann Hentschel
Partner | Sector Lead Transportation, Hospitality & Services
Technology Strategy & Transformation
thentschel@deloitte.de

Tobias Koppe
Director | Co-Sector Lead Transportation, Hospitality & Services
Technology Strategy & Transformation
tkoppe@deloitte.de

Raphael M'Barek
Manager | Transportation, Hospitality & Services
Technology Strategy & Transformation
rmbarek@deloitte.de

Deloitte.

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited (DTTL), its global network of member firms, and their related entities (collectively, the "Deloitte organization"). DTTL (also referred to as "Deloitte Global") and each of its member firms and related entities are legally separate and independent entities, which cannot obligate or bind each other in respect of third parties. DTTL and each DTTL member firm and related entity is liable only for its own acts and omissions, and not those of each other. DTTL does not provide services to clients. Please see www.deloitte.com/de/UeberUns to learn more.

Deloitte provides industry-leading audit and assurance, tax and legal, consulting, financial advisory, and risk advisory services to nearly 90% of the Fortune Global 500® and thousands of private companies. Legal advisory services in Germany are provided by Deloitte Legal. Our people deliver measurable and lasting results that help reinforce public trust in capital markets, enable clients to transform and thrive, and lead the way toward a stronger economy, a more equitable society and a sustainable world. Building on its 175-plus year history, Deloitte spans more than 150 countries and territories. Learn how Deloitte's approximately 457,000 people worldwide make an impact that matters at www.deloitte.com/de.

This communication contains general information only, and none of Deloitte GmbH Wirtschaftsprüfungsgesellschaft or Deloitte Touche Tohmatsu Limited (DTTL), its global network of member firms or their related entities (collectively, the "Deloitte organization") is, by means of this communication, rendering professional advice or services. Before making any decision or taking any action that may affect your finances or your business, you should consult a qualified professional adviser.

No representations, warranties or undertakings (express or implied) are given as to the accuracy or completeness of the information in this communication, and none of DTTL, its member firms, related entities, employees or agents shall be liable or responsible for any loss or damage whatsoever arising directly or indirectly in connection with any person relying on this communication. DTTL and each of its member firms, and their related entities, are legally separate and independent entities.

Issue 02/2024