

Data-Driven Process Reengineering of the SAP Order-to-Cash Cycle Using Process Mining: A Case Study With Signavio

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Abstract: The increasing complexity of enterprise-level integrated IT systems and their interconnection at the level of different departments creates a growing need for data-driven methods for optimizing business processes. This paper investigates the use of SAP Signavio Process Intelligence for analyzing the Order-to-Cash (O2C) cycle by leveraging real transactional data extracted from a SAP ECC environment. The aim of this research is to investigate how processes such as Order-to-Cash (O2C) can be optimized using SAP Signavio Process Intelligence in order to enhance the operational efficiency and increase the organizational performance. The proposed approach integrates the quantitative analysis of process variants with the qualitative assessment of conformance to the standard O2C process model, focusing on whether the actual sequence of activities follows the expected step-by-step process flow. The anomalies and inefficiencies are detected through Signavio visualizations and compliance checks, providing a detailed overview of how O2C processes are effectively carried out. Based on the obtained results, a process reengineering model is developed, highlighting the potential for automation and standardization, and for reducing the execution time. The results demonstrate that integrating business process analysis techniques using the existing data within an integrated ERP system can lead to significant operational improvements and to managerial recommendations with a direct impact. The paper concludes with a series of proposals addressed to organizations seeking to implement mechanisms and practices for the continuous process optimization in integrated ERP environments, highlighting the major importance of modern process analysis and management tools for the success of digital transformation strategies.

Keywords: Order-to-Cash, Process Mining, SAP ECC, SAP Signavio, Process Reengineering, ERP Analytics, Digital Transformation.

1. Introduction

The digital transformation of SAP processes is an essential step in aligning economic entities with the principles of Industry 4.0, where interoperability, transparency, and efficiency are the pillars of competitiveness. The integration of process mining solutions into business process analysis is entirely embedded in the Industry 4.0 paradigm, where data becomes the core of operational decisions (Zhong et al., 2017). A powerful tool designed for in-depth process analysis is SAP Signavio Process Intelligence – SAP SPI (Sola et al., 2023). It enables economic entities to optimize operations, improve customer service, and identify compliance violations. In addition, it uses data from various systems (such as ERP and CRM) to

provide information about the real flow of business processes. This tool helps organizations understand how their processes work, identify bottlenecks, and discover the main causes and effects of problems. Therefore, this tool is highly valuable for economic entities that want to improve operational efficiency and ensure regulatory compliance (Sola et al., 2023). The authors note that the use of this tool enables data set analysis, extracted from the database generated from the economic processes. The analysis of the data allows relevant conclusions for a company's management. It is known that SAP SPI solutions can be linked and integrated with the entire SAP ecosystem and tools such as SAP Build Process Automation

(SAP BPA), these integrations being used to model economic processes (decisions, improvements, etc.). In addition, SAP SPI, as an application within the intelligence area, is useful for operational activities, particularly for process optimization. It can also support risk management activities and even contribute to customer management processes. When discussing the benefits of SAP SPI, a few can be mentioned: improved decision-making, collaboration and transparency, as well as continuous improvement. Moreover, it is a key component of SAP's business process transformation portfolio, providing organizations the necessary tools to discover and identify hidden value in their processes and generate sustainable improvements (Ubaid & Dweiri, 2020). The transition from SAP ECC (Catt, 2008) to SAP S/4HANA (Kim et. al., 2025) serves as a major catalyst for the enhancement and refinement of the O2C process. Therefore, migrating to SAP S/4HANA plays a central role in ensuring the long-term sustainability, agility, and competitiveness of enterprise operations (Neugebauer et. al., 2024) is not just a technological upgrade, but an essential step towards sustainable digital transformation and alignment with the strategic vision of Industry 4.0 (Lukka & Wouters, 2022).

The remainder of this paper is organized as follows. Section 2 reviews the related work on process mining and the use of SAP Signavio Process Manager for the O2C optimization. Section 3 presents the proposed methodology, including problem definition, the data sample, data processing and analysis. Further on, Section 4 discusses the results and their use in Data-Driven Process Reengineering in the Order-to-Cash Cycle. Finally, Section 5 concludes this paper and outlines the directions for future research.

2. Literature Review

Process mining focuses on the discovery, analysis, and management of data within business processes, aiming to monitor and improve real-world processes (Mayer et al., 2023, Tang et al., 2023). Van Der Aalst et al. (2011) highlight a number of attributes when discussing the concept of process mining, such as process discovery or conformance checking, even details about social network or organizational mining, automatic construction of simulation models, model extension, remodeling, prediction, and history-based recommendations.

One of the key benefits of process mining cited in the literature is its objectivity, as it helps organizations improve process models to increase productivity, faster results generation using accurate data, identifying exceptions and anomalies, and facilitating conformance checking to avoid deviations that might affect information flows and decision-making. It can provide new perspectives on the same data set, and even generate different insights (Banciu, Vevera & Popa, 2023). Szelągowski (2018) uses four steps in process mining implementation: process modeling, process analysis aspects or process redesign, as well as process implementation and, of course, everything related to process monitoring and control.

Process modeling refers to developing a process model that aligns with the processes performed within the organization ("as-is") (Da & Duan, 2019). Process analysis aims to identify problems related to the processes being carried out, as well as all documents related to them that could be useful in streamlining the processes (Delic & Eysers, 2020; Dumitrache et al., 2017). During the process redesign phase, modifications are defined to overcome the shortcomings of the current processes and to align them with the organization's strategic objectives. This phase results in the development of a 'To-Be' process model. Process implementation involves deploying the new process model resulting from the previous phase. Process monitoring and control entails analyzing data during process implementation to identify whether the changes made have produced the expected results and whether the organization's objectives are being achieved or not.

Most often, studies have focused on the use of process mining to detect and remove anomalies in the context of SAP use in various industries (retail, telecommunications, IT services, business travel, etc.) and for various organizational functions (accounting, control, internal audit, external audit, human resources, production, sales, etc.) (Oliveira & Sousa, 2021). Anomaly detection was often achieved by using the Predictive Analysis Library (PAL) and adopting the k-Means clustering algorithm as a data mining algorithm. In the studies identified by the authors of the current article, several categories of process mining algorithms were found: fuzzy miner (Gomes, de Lacerda & da Silva Fialho, 2022),

heuristic algorithms, genetic algorithms and the α -algorithm and others (Corallo, Lazoi & Striani, 2020, Augusto et al., 2022).

The most widely used process mining software tools are ProM, Disco, ProM & Disco and Celonis (Mahendrawathi et al., 2018).

However, there are few recent studies that use Signavio in process mining in SAP (Scheruhn & Nath, 2024; Nida, 2024; Kolluri, 2025). The application of data mining techniques and SAP Signavio Process Manager to the optimization of order-to-cash (O2C) processes remains insufficiently explored in the existing literature. Scheruhn & Nath (2024) identify O2C as one of the models that define the Enterprise Online Guide (EOG), an integrated IA model that provides a holistic view of a company's various categories of information. However, they do not test how SAP Signavio can improve and optimize O2C processes. Nida (2024) tested O2C processes using SAP Signavio within a case study. The research focuses primarily on process mapping and problem identification in invoicing and order processing rather than on measuring performance improvements. The case study was exploratory and consisted in analyzing the results of SAP Signavio's use over a period of at least 12 months, with data collected through interviews with specialists involved in this process.

Due to the insufficient investigation of SAP Signavio's use in optimizing O2C processes, improving company performance and increasing managerial efficiency, the aim of this article is to carry out an exploratory research based on a case study conducted within a medium-sized company operating in the manufacturing industry. Small entities often face staff deficiencies, encounter challenges in integrating new technologies (Eseryel et al, 2020), and face risks due to

insufficient internal control and internal audit. Using a tool such as SAP Signavio can be a real help for mitigating such limitations and can provide timely and useful information in risk management (operational risk, financial risk, etc.) with positive effects on the organization's economic efficiency (Kramarenko, 2025).

3. Research Methodology

The aim of this research is to investigate how SAP Signavio Process Intelligence can be applied to optimize Order-to-Cash (O2C) process in order to ensure an increased operational efficiency with beneficial effects on the organizational performance. The case study method was used, which aims to investigate how, based on the quantitative and qualitative data provided by the analysed company case study, the use of SAP Signavio contributes to improving the O2C process. This method is commonly used in research that aims to optimize processes through new technologies, including artificial intelligence (Kääriä & Shamsuzzoha, 2024, De Goeij & Gelsomino, 2026). The application of the method in the analysed company case study consisted in the following steps (Figure 1).

3.1 Problem Definition

The research problem was defined in terms of technological, organizational, and environmental contexts. Understanding these contextual aspects allows one to identify the need to optimize the organization's processes. To understand the technological context, the organization's IT infrastructure was analyzed and the quality of data extracted from the organization's ERP system was evaluated (Awa & Ojiabo, 2016).

For the economic context, this paper considered the size and organizational structure, its business

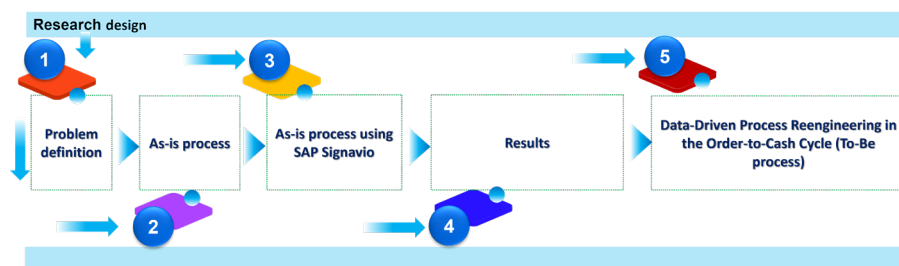


Figure 1. The Implementation of the case study steps for Data-Driven Process Reengineering of the Order-to-Cash Cycle using SAP Signavio Process Intelligence

models, economic processes, the mechanism for data collection (Domenteanu, Diaconu & Delcea, 2025), circulation and use by different departments or decision-making centers, the organization's readiness for innovation, and management support. The environmental context refers to competitiveness between companies in terms of adopting new technologies, but also to regulatory constraints that force entities to rely on technologies in order to reduce administrative costs such as audit costs or those related to compliance with legal requirements imposed on the industry or specific categories of entities (Sharma et al., 2023, Petrescu et al., 2025).

The need for process optimization must be justified through a cost-benefit analysis. The use of SAP Signavio can lead to changes in IT infrastructure, internal processes, and employee behaviors and responsibilities, and therefore its use should be considered only if it proves to be feasible.

The analyzed entity is a medium-sized manufacturing company that faces strong competition from similar entities, particularly from a large entity that is part of a group of companies. The company has experienced multiple changes in management in recent years, the current leadership is open toward the adoption of new technologies to support long-term process optimization and cost efficiency. Fluctuations related to administrative staff, large volumes of information, errors, delays in processing transactions, customer litigation, cash flow management challenges, compliance with tax and financial reporting requirements etc. represent contextual aspects that were considered relevant in selecting this entity for the analysed case study.

3.2 As-is Standard Process

This paper investigates several aspects related to an empirical analysis of the O2C economic sales process. The analysed sample consists of 3,293 cases and 29,732 events extracts from SAP tables structured according to the standard SAP O2C process, which starts with the customer's request for a specific product, continues through the quotation phase and sales order creation, and is followed by delivery, goods dispatch, invoicing, and payment collection.

3.3 As-is Process Using SAP Signavio

Data analysis and processing were performed in SAP Signavio Process Intelligence (SAP SPI). The aim is to demonstrate, through this case study, how a data-driven analysis applied in SAP SPI can support the reengineering of economic processes in the O2C cycle by identifying anomalies and formulating improvement proposals that contribute to increasing the organizational performance. Process analysis implies the visualization of the actual execution flows using the explorer variant, highlighting the dominant path ("happy path") alongside secondary variants. Performance measurement refers to the evaluation of lead times, overall throughput times, waiting times, and rework rates across different process segments. Anomaly detection is performed by identifying the non-compliant behaviors, such as activities performed out of sequence, redundant repetitions, or significant delays in document flows. Visualizations and indicators require the use of process maps, heatmaps, and key performance indicators (KPIs) to enable a systematic evaluation of process efficiency and bottlenecks. The resulting As-Is model provides an empirical representation of how transactions were executed in practice, including both the standard process flow and variations that occurred in daily operations.

3.4 Results

The existing studies evaluate process efficiency using metrics that focus on technical feasibility, business impact, or user satisfaction (Viswanathan, 2024, Leng et al., 2025). The results of SAP Signavio's use were evaluated from the perspective of operational efficiency, with positive effects on the organization's performance. SAP Signavio provided information that allows to track indicators such as invoicing rate, clearing rate, collection rate, average time to complete a stage in an O2C process, the time taken to complete a stage per employee, the workload of employees assigned to different stages of the process, and non-compliant information intended for certain users (accounting, marketing, sales, production, etc.). Such observations are extremely useful to managers in decision-making that could optimize not only this process but also the activity of various departments within the company.

3.5 Data-Driven Process Reengineering in the Order-to-Cash Cycle Operational (To-Be process)

The evidence provided by SAP Signavio visualization and available data were used to conduct investigations that would yield other relevant information for managers' decision-making. Process bottlenecks, non-conformities, delays, redundancies, employee inefficiency in completing certain stages of the process, their impact on users can be analyzed in a timely manner and sometimes just in time by management in order to streamline the O2C process. A process that eliminates or reduces these deficiencies as much as possible is the To-Be process. It will be the starting point for a new iteration in SAP Signavio, allowing the management to monitor process efficiency and anticipate potential deviations and risks. Such benefits would be extremely difficult to achieve otherwise (without intelligent technologies) at the level of a medium-sized enterprise and would require long periods of time and substantial resource allocation that would not ensure the same level of accuracy and efficiency.

4. Results and Discussion

4.1. As-Is standard Model

In order to analyze the actual functioning of the O2C economic process, illustrated in Figure 2, within the analyzed company, the first step consisted in modeling the process based on event logs extracted from SAPECC. The resulting As-Is model provides an empirical representation of how transactions were executed in practice, including both the standard flow and variations that occurred in daily operations. This modeling activity allows the identification of the "happy path", which means the most frequent sequence of activities, as well as secondary variants that deviate from the normal process structure. The figure below shows the implemented O2C process highlighting the main stages (sales order creation, delivery, stock movement, invoicing) and additional branches generated by exceptions such as returns or credit notes. The analyzed process forms the basis for further performance evaluation and for diagnosing inefficiencies that will underpin reengineering proposals (the To-Be model).

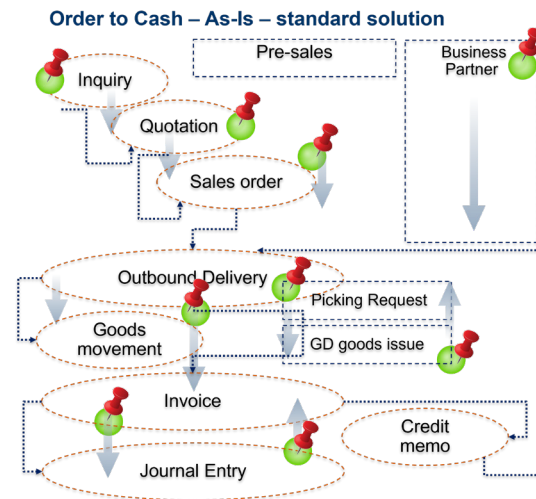


Figure 2. SD (Sales and Distribution) - order-to-cash - process, standard implementation

4.2. O2C Process Analysis Using SAP Signavio (As-Is Signavio Model)

After modeling the Order-to-Cash process (As-Is), the next step consists in evaluating process performance and identifying the deviations from the standard flow. This step is beneficial for understanding the extent to which the process is performing as expected and where bottlenecks or delays occur. The analysis is based on key performance indicators such as total cycle time, execution times for each activity, and the frequency of process variants. In addition, the visualizations generated in SAP Signavio Process Intelligence allow the detection of redundant activities, unnecessary repetitions, and deviations from the normal process. Identifying these elements provides a clear picture of the sources of inefficiency and paves the way for formulating reengineering proposals. Thus, the analysis of the As-Is process performance forms the basis for designing a more efficient and transparent To-Be model.

The following aspects were addressed based on data collected from SAP ECC and processed in SAP SPI: KPI (e.g. processing times, lead time, throughput time, waiting times), deviations and anomalies (e.g. steps performed outside the logical sequence, redundant repetitions, major delays), bottlenecks, where the flow slows down significantly (e.g. billing or returns), interpretation of Signavio visualizations (e.g. heat maps, time graphs, process variants), management-related implications (e.g. how these inefficiencies affect cash flow, customer relations, and internal costs).

The workflow for importing into SAP SPI the data extracted from the source system (SAP ECC), transformed with SAP Power Query, and mapped into a data model for operational analysis is presented in Figure 3. The figure below highlights the current (standard ‘As-Is’) flow, in which data from SAP ECC is extracted, transformed, modeled, and then uploaded into the SAP SPI analysis environment.

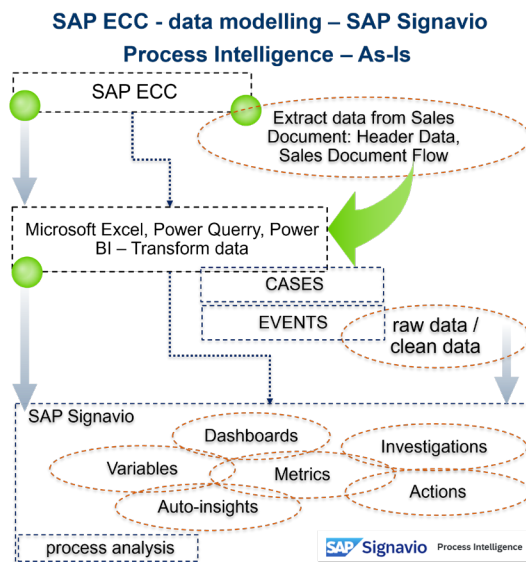


Figure 3. Data Modeling Flow from SAP ECC to SAP Signavio Process Intelligence – “Signavio As-Is” Situation

The extraction from SAP ECC is followed by processing and transformation using Microsoft Excel, Power Query, and Power BI tools, after which the data is loaded into SAP SPI to support process analysis and the identification of optimization opportunities.

In Figure 3, each “case” corresponds to a complete instance of the O2C process, for example, a sales order that goes through all stages up to payment collection.

Each event in a “case” represents a specific action recorded in the SAP ECC system, such as “create sales order”, “delivery”, “invoicing” or “payment collection”. The existence of intermediate steps necessary to transform this data into the SAP SPI model (i.e. using Power Query - eventually, two *csv files about cases and events) shall be created in a standard format compatible with process analysis. The event log was built based on the SAP transaction data extracted using transaction SE16N from several tables relevant to the Order-to-Cash process. The data was exported in CSV format and

subsequently processed using Microsoft Power Query, resulting in a final dataset containing 3,293 cases and 29,732 events. The Case ID was defined as the unique sales order number, extracted from the VBAK table (Sales Document: Header Data). Thus, each case represents a complete instance of the Order-to-Cash process, from initiation to financial completion. Reconstructing the event log involved integrating data from several SAP tables, including VBAK (Sales Document: Header Data), VBAP (Sales Document: Item Data), VBFA (Document Flow), LIKP and LIPS (Delivery Header and Item), VBRK and VBRP (Billing Header and Item), BKPF and BSEG (financial documents), as well as from master data tables such as KNA1, KNB1, KNVV (customer data) and MARA and MAK1 (material data). The activities were identified based on the statuses of SAP transactions and the events associated with the documents extracted from these tables. Each activity was mapped to a standardized, business-process-oriented name (e.g. Delivery, Goods Movement, Invoice, Credit Memo Request, Credit Memo) to ensure the semantic consistency of the process model.

For each event, the timestamp was constructed by concatenating the document creation date and time fields into a single temporal attribute. In cases where timestamps were missing, they were filled in using the closest valid operational timestamp, provided that this substitution was consistent with the process logic. After conversion, this data is loaded into SAP Signavio Process Intelligence, where each case is reconstructed chronologically, and events are used for visualizing the actual flow of the O2C process (Signavio “As-Is”).

Thus, Figure 3 highlights how operational data from SAP ECC -Sales and Distribution (SD) module is converted into process data (cases and events), enabling the performance analysis and identification of bottlenecks in the O2C process chain analyzed. In the context of business process analysis (Process Intelligence), cases and events are the fundamental concepts used for describing and reconstructing the actual flow of a business process. By combining these two concepts - cases and events - using SAP SPI, the aim was to reconfigure all the steps performed within the O2C economic process, with the goal of identifying a series of variations, delays, or bottlenecks, and, last but not least, deviations from the standard

process. In the O2C process analysis using SAP SPI, the authors of this article examined the performance and behavior of the workflow from three complementary perspectives: Event count, Case Count and Cycle Time.

Taken together, these three indicators offer an integrated perspective on the performance of the O2C process and reveal the areas where improvements are possible. Figure 4 details a system architecture that highlights the data flow from SAP ECC (O2C). Of course, governance, security, and effective operation were also mentioned, using SAP systems (DEV-development-QAS-quality-PRD-production, system monitoring, HA - High Availability, and DR - Disaster Recovery), all supporting a complete end-to-end representation of the process.

Upon integration of the data extracted from SAP ECC into the SAP SPI platform, the system

automatically reconstructed the actual flow of the O2C process. As shown by the analysis performed after modeling the data and loading it into SAP SPI, Figure 5 illustrates the discovered model, which deviates significantly from the standard solution highlighted in Figure 2. The automated analysis identified unexpected branches and rework loops between the “Goods movement”, “Delivery”, and “Invoice” activities, indicating operational anomalies such as delivery returns, order changes, or rebilling processes. Furthermore, the distribution of cycle times suggests delays in the delivery phase, while the high frequency of events for “Goods movement” indicates redundant steps or partially manual processes. This analysis clearly highlights the difference between the standard O2C framework and the real-world process behavior in the organization, which enables targeted process improvements.

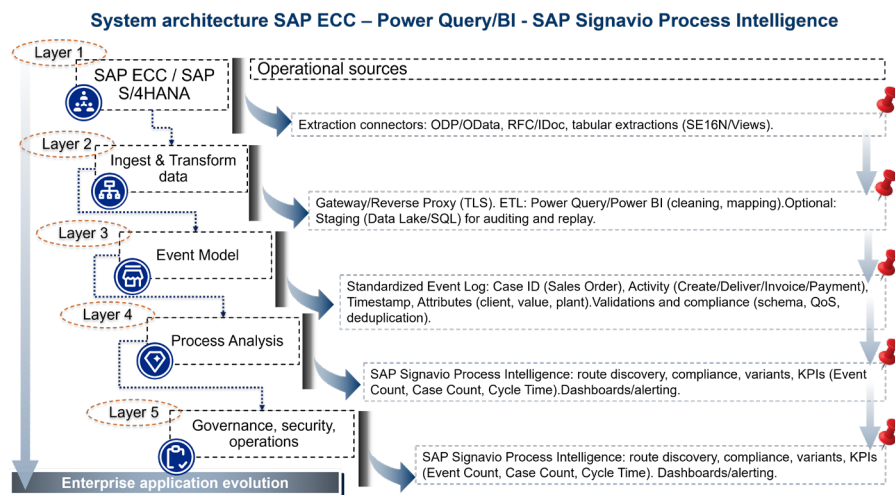


Figure 4. System Architecture for Order-to-Cash Process Analytics with SAP ECC and SAP Signavio Process Intelligence

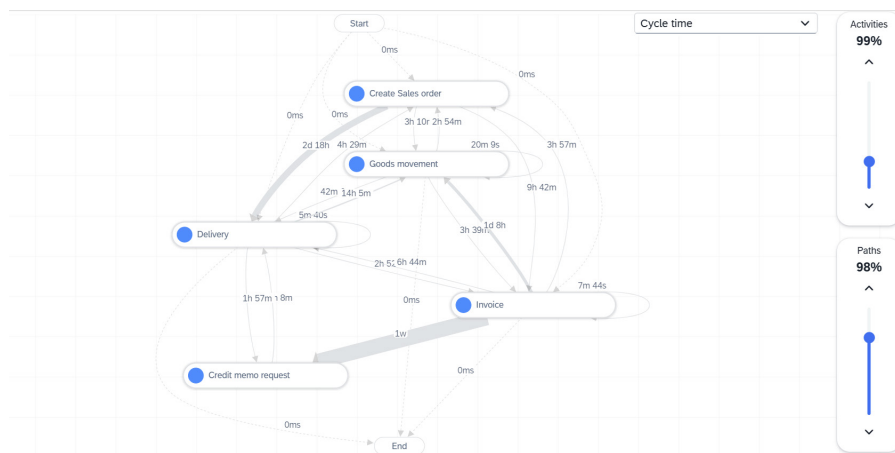


Figure 5. Signavio As-Is Order-to-Cash Process Visualization Based on Cycle Time Analysis

In terms of data analysis and visualization within SAP SPI, Figure 6 depicts the O2C process analyzed from the „Case Count” perspective, highlighting the distribution and frequency of cases for each activity within the actual process flow. It can be seen that most process instances (3,293 cases) start with the Create Sales Order activity, followed by the Goods Movement, Delivery, and Invoice stages, which maintain a dominant sequence in most of the cases analyzed. However, the visualization also shows significant variations from the standard route, such as loops between “Goods movement” and “Delivery,” suggesting possible re-deliveries or corrections in the logistics flow. There are also alternative paths to “Credit memo request,” associated with the return processes or post-invoicing adjustments. Therefore, the Case Count analysis confirms that the process does not always follow the standard linear flow, but includes deviations caused by operational exceptions, reprocessing, or special order handling.

The Event Count analysis focuses on the total number of events, i.e. the actions executed in the system for each activity and process path. Accordingly, Figure 7 presents the O2C process from the Event Count perspective, emphasizing the overall volume of events associated with each activity as well as the connections between them. The results show a high density of events around Goods Movement (9125) and Delivery (9223) activities, suggesting a large number of logistics operations, inventory updates, or re-execution of the same steps in the process. By comparison, the Create Sales Order (3293) and Invoice (7605) activities have a lower but still significant frequency, confirming that most Order-to-Cash flows go through these stages completely. The presence of alternative paths between Delivery, Invoice, and Credit Memo Request indicates the existence of exceptions, such as post-invoicing corrections or return processes, which contribute to an increase in the total volume of

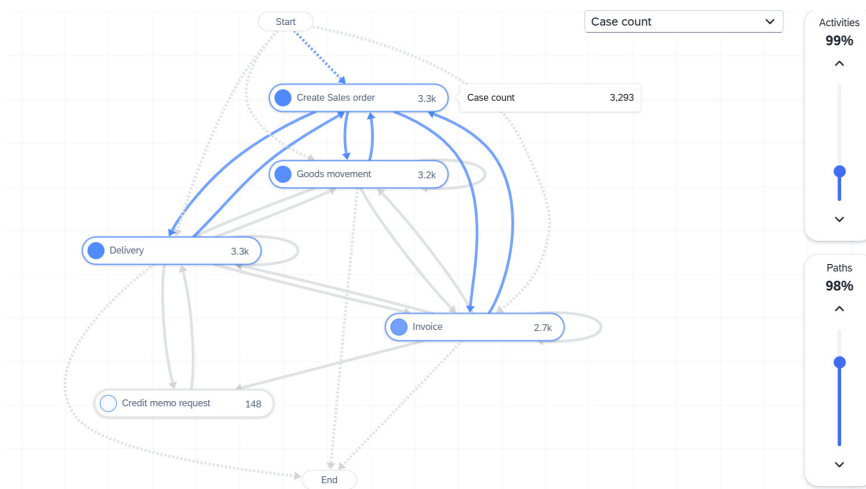


Figure 6. Signavio As-Is Order-to-Cash Process Visualization Based on Case Count Analysis

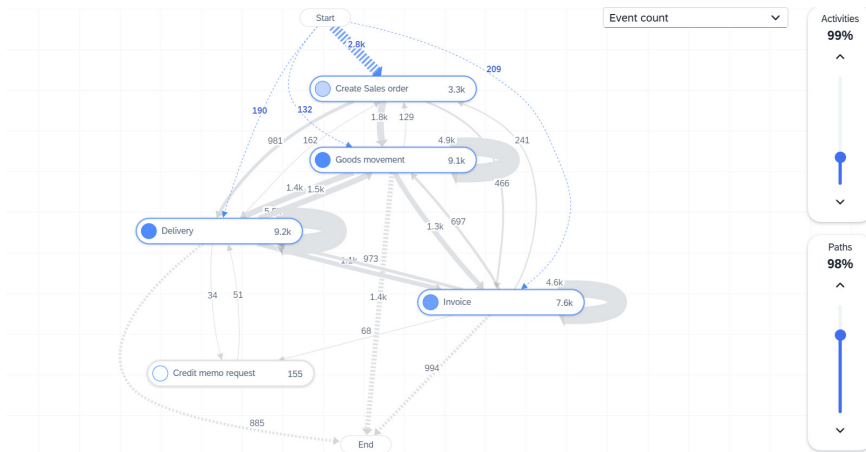


Figure 7. Signavio As-Is Order-to-Cash Process Visualization Based on Event Count Analysis

events. Accordingly, the Event Count perspective highlights the degree of operational intensity and detects points of activity redundancy, which can hinder the overall effectiveness of the O2C cycle.

4.3. Results

The analysis of the O2C process in SAP SPI, conducted from three perspectives - Case Count, Event Count, and Cycle Time - provides a complete picture of how the operational flow is actually executed. The Case Count visualization highlighted the main routes frequencies, confirming the typical sequence “Create Sales Order – Goods Movement – Delivery – Invoice”, but also revealing operational deviations such as returned orders or corrective invoices. The Event Count analysis showed a high intensity of events in the logistics area, suggesting repetitive steps and manual activities that can lead to inefficiencies. From a Cycle Time perspective, significant delays were identified between the delivery and invoicing stages, indicating potential bottlenecks in the process flow. Overall, the combination of these analyses confirms that the actual process deviates from the standard model, providing the organization with a solid basis for initiating an optimization plan and aligning the O2C process with the best performance practices.

The analysis performed in SAP SPI revealed significant differences between the theoretical O2C model (As-Is standard) and the actual execution pattern identified in the data extracted from SAP ECC. The results confirm that the actual process contains multiple branches and route variations caused by re-deliveries, order changes, and corrective invoicing processes.

The Case Count-based visualization showed that most cases follow the standard route, but approximately 15–20% of them include additional activities or operational loops. From an Event Count perspective, a concentration of activity volume was observed in the “Goods Movement” and “Delivery” stages, suggesting an intensely processed logistics area and possible redundancy of certain steps. Referring to the Cycle Time analysis again, it indicated significant delays between delivery and invoicing, directly impacting the total process cycle time. These time deviations can be correlated with manual dependencies in the approval process or with additional system checks specific to certain customers or order types.

Comparing the three perspectives revealed a lack of consistency between process flows and internal operating policies, signaling the need for a review of the intermediate steps.

It was also found that certain events, such as credit memo requests, frequently occur outside the standard route, indicating potential compliance issues.

4.4 Data-Driven Process Reengineering in the Order-to-Cash Cycle (To-Be Process)

Data-Driven Process Reengineering in the Order-to-Cash Cycle (To-Be process) enables managers to identify intervention points where appropriate measures and decisions can be applied using a series of metrics generated by SAP Signavio, as well as by indicators that can be determined from the data and these metrics. For example, in the analysed case (Figure 8), several anomalies can be observed in the O2C process. Delivery is followed



Figure 8. Anomalies identified in SAP Signavio

by the movement of goods but does not go through invoicing. Deliveries are invoiced late, often at the end of the process. Invoicing is delayed from several weeks to several months. This causes delayed cash receipts. Records provided by SAP Signavio indicate that management is focused primarily on sales and neglects to recognize the transactions in the accounting records in a timely manner (cases of sales without invoices that were collected and invoices issued long after the process was completed were identified).

If certain matrices are analyzed, these observations are confirmed. The invoicing rate for deliveries made during the observed period is 75.69%. A significant portion of deliveries is invoiced late. Of the total number of deliveries, only 57.30% were cleared, which indicates a practice of postponing the recognition in the accounting records of a significant number of deliveries, sometimes until close to the time of their collection.

To provide additional information that would further improve the understanding of the analysed cases based on the SAP Signavio visualization, the median and percentiles were calculated and interpreted. Figure 9 shows the monthly distribution of delivery, invoicing, and clearing. While deliveries follow a pattern consistent with a standardized process based on contracts with customers and scheduled deliveries, invoicing and clearing show at least significant variations. There is a higher workload with regard to invoicing and clearing in the months 2, 3, 4 and 9, 10 and 11, respectively, and a lower efficiency in the months 12 and 1.

From the information provided by management, it was found that the effort increases in the months prior to the annual reporting and profit declaration and decreases at the end of the year and the beginning of the following year. The management does not have a detailed system for monitoring the causes of significant discrepancies between deliveries on the one hand and invoicing and clearing on the other hand. Most often, the management investigates the causes of these situations either upon customer notification or when the process approaches the collection date or exceeds that date. Difficulties are also identified in months 7 and 8, corresponding to the vacation time, which are followed by a period of recovery represented by months 9 and 10. The management confirms that, during certain periods, the billing and accounting staff are overworked, with a significant part of their work being allocated to correcting the identified errors.

Table 1 presents the analysis of percentiles such as the median, standard deviation (SD), and coefficient of variation (CV). The delivery times are fairly consistent and clustered, since the 25th–75th percentile range (12.5 units) is small. The upper tail (90th to max) grows slightly, showing a few slower deliveries. Invoicing has a wider middle range (31 units between Q1–Q3) and a more gradual increase up to the maximum. In certain cases, the invoicing can take very long. Some clearings are quick, but others take substantially longer. The mean (157.25) is very close to the median, so there's minimal skew despite the broad range. The results confirm that Delivery is the most stable series, while Clearing

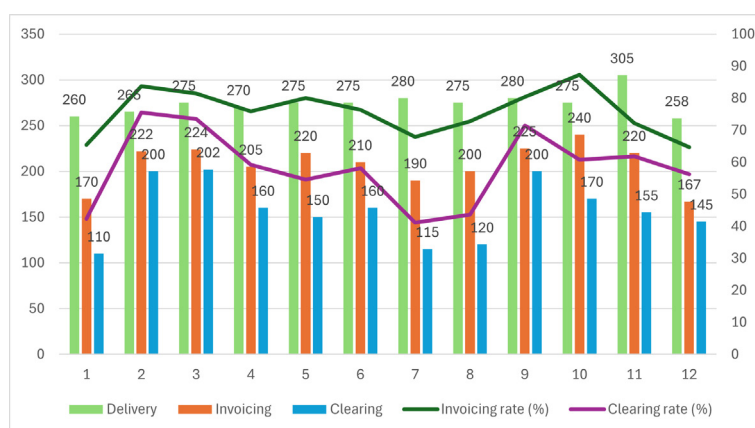


Figure 9. Delivery, invoicing and clearing distribution

Table 1. Percentiles analysis

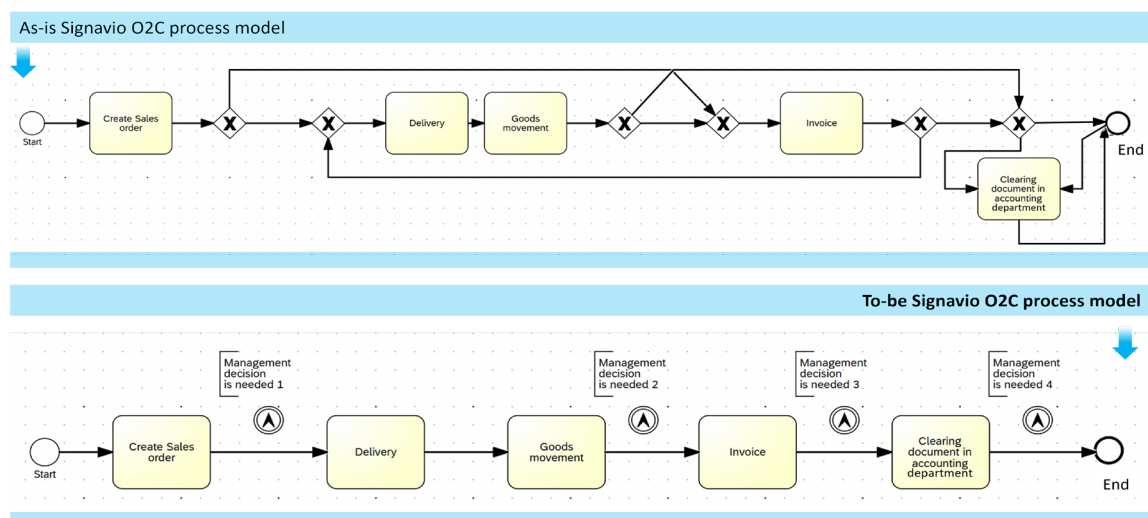
Percentile	Value (Delivery)	Value (Invoicing)	Value (Clearing)
Minimum (0th)	258,00	167,00	110,00
10th	258,60	167,90	111,50
25th (Q1)	266,25	192,50	126,25
50th (Median)	275,00	215,00	157,50
75th (Q3)	278,75	223,50	192,50
90th	297,50	235,50	201,40
Maximum (100th)	305,00	240,00	202,00
Mean	274,42	207,75	157,25
Standard deviation (SD)	12	22,54	32,27
Coefficient of variation (CV)	4,37%	10,85%	20,53%

is the most volatile, which is evidence of cash flow risk which should be addressed through targeted process or collection action by management.

Based on this information, the management can implement measures for optimizing the process and even more than that. Our case highlights a number of risks to which the company is exposed. Firstly, there is a discrepancy between the business figures and the accounting records. The value of deliveries identified by the management differs from the turnover reported in the company's financial statements due to the delays in invoicing and clearing. If, in this situation, the management takes decisions based on the accounting data, it relies on information that does not reflect operational reality. Another risk is non-compliance with financial reporting requirements because the current revenues will be recognized in the future. The performance indicators calculated based on

turnover will be distorted. It is in the company's interest to collect payments from customers as quickly as possible. However, almost 60% of deliveries are difficult to collect, often beyond the terms stipulated in the contracts with customers. The company will eventually face cash flow problems. Another risk is the fiscal risk. A delayed recognition of revenues generates a fiscal risk related to the payment of income tax and VAT.

Figure 10 illustrates a comparison between the As-Is process using Signavio and the To-Be process, highlighting the points where management intervention is required. The decisions that the management will have to make to optimize the O2C process will target not only the O2C process itself but also the human resources, sales, accounting, and debt collection departments. To evaluate the To-Be process, the information provided by the management was compared with

**Figure 10.** From As-Is to To-Be O2C process

the results of the analyses which were carried out based on SAP Signavio and the identified areas that the management had overlooked but that would be of great help in streamlining O2C processes (Table 2).

The evaluation of the “To-Be” process was not based on an evaluation of the subsequent impact of the company’s use of Signavio, but rather on the additional information generated by the model, which allows for a much more detailed investigation of process anomalies and errors.

5. Conclusion

The analysis of the O2C process, performed using the SAP SPI platform, has demonstrated the importance of end-to-end visibility for the actual execution of business processes. By comparing the standard model (theoretical As-Is) with actual data extracted from the SAP ECC system, significant deviations were identified that influence both process performance and compliance. The multiple perspectives provided by the Case Count, Event Count, and Cycle Time indicators

enabled a comprehensive assessment of the volume, intensity, and duration of activities in the operational flow. The results highlighted critical areas, particularly in the delivery and invoicing stages, where delays and redundant activities were identified. These findings emphasize the need to redefine the O2C flow as an optimized (To-Be) model that reduces the execution times and eliminates uncontrolled variations. Furthermore, the continuous integration involving SAP ECC, Power BI, and SAP Signavio provides a solid foundation for governance, monitoring, and continuous performance improvement for the business process. In summary, the findings demonstrate that applying process mining techniques is an effective means of supporting digital transformation and the optimization of key business processes.

By connecting the SAP ECC, Power BI, and SAP Signavio platforms, the analysed organization achieves complete digital visibility over its workflows - the foundation of the smart enterprise concept. This approach enables the transition from reactive monitoring to proactive

Table 2. To-Be process evaluation

Issues	The current management practices	Input for management decisions based on SAP Signavio
Variations in deliveries caused by customer behavior or by information received from or sent to customers	An increase in the frequency of communication with customers and in the flow of documents and information	Causal analysis of delivery variations: discrepancies from contracts; document errors; poor timing; manual processing; process re-runs
Variations in deliveries caused by internal factors	Monitoring the workload of the delivery team	Causal analysis of delivery variations: unrealistic targets; long execution time; errors and omissions; manual processing; process re-runs
Variations in invoicing	Monitoring the workload of the invoicing team	Causal analysis of invoicing variations: invoiced transactions without goods movement; goods movement without transaction invoicing; delivery errors; discrepancies from the customer’s order; transaction cancellations or modifications; long processing time; manual processing; process re-runs
Variations in clearing	Monthly account closings and reconciliations in the following month	Causal analysis of clearing variance: invoices with errors; invoices from other periods; goods movement without an invoice; invoices without goods movement; duplicates; omissions; collections without invoicing; clarifications with customers; manual processing
KPIs	Number of deliveries per month / number of contracted deliveries; number of invoices issued; delivery processing time; invoice processing time; goods movement for the completed deliveries; number of corrected invoices; number of modified deliveries; number of invoices not collected by the due date	Invoicing rate; clearing rate; collection rate; O2C process completion time; completion time for each stage of the O2C process; number of processes completed without bottlenecks; number of processes completed but with bottlenecks; number of uncompleted processes with bottlenecks

optimization supported by predictive analytics and automation.

Based on the obtained results, it can be concluded that the transition from SAP ECC to SAP S/4HANA represents a major opportunity for modernizing and optimizing the O2C process. The new platform offers an open architecture based on SAP HANA in-memory technology, with native integration capabilities for the adoption of the emerging technologies, such as AI, RPA, and IoT, which serve as key enablers for achieving the end-to-end digitalization and automation of processes.

In practice, this study contributes to the academic literature by providing an example of integration between real ERP data and a visual/diagnostic analysis performed with SAP Signavio Process Intelligence. Furthermore, this paper highlights practical (managerial) insights - the identification of anomalies, deviations, delays, and unnecessary rework activities within the O2C economic process. Using SAP Signavio Process Intelligence for process optimization and improving the operational efficiency in companies is attracting growing interest. The outcome of these investigations is the proposal of process reengineering scenarios (To-Be model) that will lead to efficiency, transparency, and cost reduction.

The findings provided by the case study are consistent with the existing studies (Nadukuru et al, 2024, Kääriä & Shamsuzzoha, 2024, Brock et al., 2024). Other studies that have used data mining with other tools such as Celonis have generated KPIs that are only relevant for improving O2C (Kääriä & Shamsuzzoha, 2024). Such metrics are the credit invoice rate, billing block rate, reverse ticket count, touchless processing rate etc. The novelty of this research consists in the fact that it has provided evidence confirming that the use of SAP Signavio has allowed to identify indicators such as the invoicing rate, clearing rate, and collection rate that have a broader utility at the organizational level and even at the macroeconomic level.

The indicators generated by this case study are useful in managing various risks. The risk of non-compliance with financial reporting requirements is particularly present in the case of small entities. The higher the clearing rate, the more it could indicate an undervaluation of receivables and the

company's reported turnover as a result of late invoice registration. Other company performance indicators based on receivables and turnover may be distorted (e.g. liquidity ratio and commercial profitability). The turnover reported by companies is the basis for calculating the GDP. Most entities in the economy are micro-, small-, and medium-sized enterprises. Operationalizing such a rate would result in a greater accuracy of the data reported by companies and the calculation of more realistic macroeconomic indicators.

The fiscal risk should not be overlooked, given that tax evasion is more prevalent among small, unaudited entities. The indicators generated by the analysed case study allow the tax risk to be reduced by reporting sales revenue, which is the main taxable income, in a timely manner. The invoicing rate can be used for improving the collection of payments from customers and for managing cash flows more efficiently. Small businesses have cash flow difficulties and are more vulnerable to a poor cash management. In addition to improving the O2C process, this study provides insights for a more proactive collection management, for predicting process errors, exchanging information across departments, and a predictive liquidity management. Such needs are explored in the existing literature (Mayer et al, 2023) and may represent a niche for future research using SAP Signavio.

However, this research was based on a case study and therefore it has a series of limitations. The observations and results are specific to this case only, even if some behaviors are very likely to occur in other similar cases. The results cannot be generalized to small- and medium-sized enterprises in the manufacturing industry. The number of observations is moderate and the analyzed period was relatively short.

Finally, this research provides several ideas for future research. Management researchers can find ideas for investigating ways to improve operational efficiency and risk management. Similar research can be conducted over longer periods and based on numerous iterations after the implementation of managerial decisions aimed at improving economic processes and integrating information provided by SAP Signavio Process Intelligence.

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