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The Role of ChatGPT in Elevating Customer Experience and Efficiency in Automotive After-Sales Business Processes

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Abstract: Purpose: The advancements in deep learning and AI technologies have led to the development of such language models, in 2022, as OpenAI's ChatGPT. The primary objective of this paper is to thoroughly examine the capabilities of ChatGPT within the realm of business-process management (BPM). This exploration entails analyzing its practical application, particularly through process-mining techniques, within the context of automotive after-sales processes. Originality: this article highlights the issue of possible ChatGPT application in selected stages of after-sales processes in the automotive sector. Methods: to achieve the main aim of this paper, methods such as a literature review, participant observation, unstructured interviews, CRISP-DM methodology, and process mining were used. Findings: This study emphasizes the promising impact of implementing the ChatGPT OpenAI tool to enhance processes in the automotive after-sales sector. Conducted in 2023, shortly after the tool's introduction, the research highlights its potential to contribute to heightened customer satisfaction within the after-sales domain. The investigation focuses on the process-execution time. A key premise is that waiting time represents an additional cost for customers seeking these services. Employing process-mining methodologies, the study identifies stages characterized by unnecessary delays. Collaborative efforts with domain experts are employed to establish benchmark durations for researched processes' stages. The study proposes the integration of ChatGPT to improve and expedite stages, including service reception, reception check-out, repair and maintenance, and claim repair. This holistic approach aligns with the current imperatives of business-process improvement and optimalization, aiming to enhance operational efficiency and customer-centric service delivery in the automotive after-sales sector.

Keywords: ChatGPT; GPT; AI; BPM; process management; after sales; automotive

JEL Classification: D22; D24; O33

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1. Introduction

The effect of market globalization is associated with increased customer demands and organizations' pursuit of excellence to achieve competitive advantages [1]. If organizations are to compete in times of economic uncertainty, it is essential to focus on improving core business processes [2]. This generates a situation in which managers seek solutions aimed at increasing efficiency and effectiveness through the automation and/or robotization of highly standardized business processes. A precise understanding of GPT's tools, such as ChatGPT, in the context of BPM, may reconfigure the conventional customer service model in the automotive sector by enhancing timely and accurate responses to customer queries, implementing intelligent chatbots, ultimately leading to a reduction in customer-query response times.

In addition to the technologies characterized by a high degree of operationalization in business, a new tool based on artificial intelligence (AI) technology has emerged—ChatGPT, a large language model developed by OpenAI, unveiled in November 2022 [3]. The implementation of ChatGPT in BPM, along with chatbot tools and other AI technologies, offers the potential to automate routine activities and improve the overall customer experience [4].

In the course of researching organizational management, it becomes apparent that publications specifically addressing the implementation of ChatGPT are underrepresented, while studies examining the broader impact of AI technologies on business-process management can clearly be identified [5,6].

Business processes (BPs) lie at the core of an organization [7]. BPs constitute a natural operational category, which means they occur in every organization [8]. To succeed in an environment of increasing market dynamics and high levels of competitive pressure, organizations need to constantly adapt their business processes [9]. business-process management (BPM) is defined in the literature as a management discipline dedicated to improving organizational performance by managing its processes [10]. Gulledge Jr and Sommer [11] identified the main components of BPM, which they classified as modeling, the implementation of automation, optimization, and process management using the process-owner role. The cross-functional role of the process owner, in the context of continuous management and process improvement, has been also indicated in the work of [1]. Other authors, by contrast, identify BPM as a technique enabling the management of operations within an organization's business-process dimension [12]. More specifically, BPM revolves around such activities as identification, definition, analysis, design, execution, monitoring, and measurement, as well as the continuous improvement of business processes [13]. In this paper, BPM is identified as a management method of a steadily growing interest [14,15], which contributes to its development towards discounting the benefits of AI-based technologies and tools.

Published studies have highlighted the benefits and limitations of AI technologies' implementation and the potential thereof to revolutionize traditional BPM processes [16]. The integration of artificial intelligence (AI) technologies in BPM can bring significant changes to traditional processes and improve the overall customer experience [6].

The literature study has revealed two cognitive gaps: a scarcity of publications addressing the subject of after-sales processes and a deficit of papers characterizing the potential of ChatGPT implementation in management.

As a result, the research problem has been defined:

> Research question: What is the potential role of implementing ChatGPT in streamlining after-sales processes in the automotive sector, particularly in terms of reducing process-completion time?

It is important to acknowledge that ChatGPT has only been in operation for a few months during the writing of this article. Therefore, this study serves to highlight preliminary considerations and outlines for future research directions.

The main objective of this paper is to identify, utilizing process-mining, the stages of the after-sales service process in the automotive sector where the implementation of ChatGPT could be applied. To achieve this objective, various methods such as bibliometric analysis, literature review, participant observation, unstructured interviews, CRISPDM methodology, and process mining were used. Given the context of the issue under study and the subject of the research, namely, authorized car-service centers, it should be emphasized that the pace of development in this type of (service) organizations is slower, compared to manufacturing organizations [17].

AI technology and the ChatGPT tool can not only revolutionize highly standardized processes, but also positively influence the design of management processes in an organization. This means that modern technologies should be increasingly considered when determining, inter alia, the level of standardization or autonomy in process execution.

2. Bibliometric Analysis: Exploring the Application of ChatGPT

To identify the research gaps outlined in the introduction, a theoretical study was carried out, employing such research methods such as bibliometric analysis and a literature review. An attempt was first undertaken to identify publications containing the keywords 'chat GPT' or 'chatGPT' in the title. For this purpose, three knowledge bases were used:

Web of Science Core Collection, Scopus, and Publish or Perish. The results of this part of the analysis are presented in Table 1, by means of selected scientometric indices.

Table 1. Selected bibliometric indices for publications identified using keywords 'chatGPT' and 'chat GPT'.

Database | Index	Web of Science	Scopus	Publish or Perish
Number of publications	No results	11	15
Publication year range	No results	2022–2023	2022–2023
Citation overview	No results	1	214

Source: own elaboration based on Web of Science, Scopus, and Publish or Perish resources, access: 3 February 2023.

The publications identified were subjected to selection, extraction, analysis, and synthesis [18]. This was followed by an initial selection, based on publication titles, abstracts, and key words [19]. Since the ChatGPT tool was introduced in November 2022, the scope of the study period was short and covered several months only (from November 2022 to February 2023). It should be noted here that for the keywords selected, no publications were identified under the criterion of 'title' in the Web of Science database. It is also worth mentioning that 1022 results were generated by the keyword 'chatbot', which does not constitute the object of this paper.

Figure 1 shows the steps in the process of publication selection for the literature review.

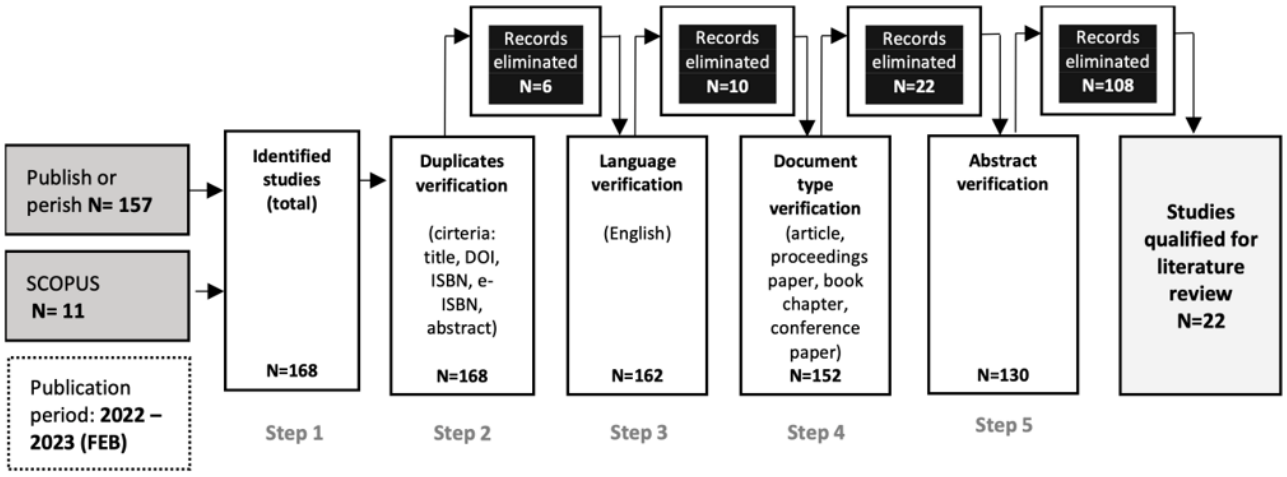

Figure 1. The process of identifying documents qualified for a literature review. Source: own study based on Publish or Perish, Web of Science Core Collection, and Scopus. Access: 3 February 2023.

In this part of the theoretical study, the following selection and elimination criteria were adopted: document type (article, book chapter, proceeding paper, or conference paper), language (English) and the discipline of science (management or business). Drawing on these criteria, based on 168 publications, 22 articles were selected for the review, 19 of which describe the chatGPT-associated opportunities and risks across various scientific disciplines in very general terms. Only three scientific studies addressing the issues related to the category of management were identified. According to the author's judgement, this results from the fact that the tool was unveiled in November 2022, yet it is very highly probable that the number of publications, in all categories, will increase rapidly in 2023, which would provide an impetus for the implementation of a literature review on chatGPT in management. During the selection process, several citations of publications lacking a DOI number, journal data, and review information were identified in the Publish or Perish database [20–23]. Given the document-type criterion, these publications were not qualified for the literature review.

In one paper [24], the author outlines the usage and limitations, showing that ChatGPT is capable of correcting its mistakes at times, but also displays overconfidence in its incorrect responses. It is quite relevant, from the perspective of the author who executed the experiment, that ChatGPT "may request for additional information to provide an answer and may be asked to explain its response. Moreover, [. . .] minor change to a question may lead to contradicting responses" (2022). The author additionally discusses "*ChatGPT's responses to common social experiments*" (2022), showing that "*ChatGPT tends to answer as humans do*" (2022). In another publication [25], the authors have categorized the following as the main benefits of ChatGPT: increased efficiency, improved accuracy, and cost savings, indicating such challengers as security concerns and limited capabilities. According to the authors, "*despite these challenges, chatGPT is a promising AI technology that can be used to automate conversations and generate more accurate responses*" [25]. In a publication by Sobania et al. [26], in turn, an attempt was made to evaluate ChatGPT in terms of software improvement. The authors found that, using a standard set of benchmarks, ChatGPT is characterized by a performance similar to Codex and dedicated DL-based APR. It is also worth noting the authors' conclusion that "*[d]espite its great performance, the question arises whether the mental cost required to verify ChatGPT answers outweighs the advantages that ChatGPT brings. Perhaps incorporation of automated approaches to provide ChatGPT with hints as well as automated verification of its responses, e.g., through automated testing, would yield ChatGPT to be a viable tool that would help software developers in their daily tasks*" [26]. Chuma et al. [27], by contrast, assessed possible ChatGPT applicability in organizations. In the authors' view, the technology should be leveraged strategically. The potential of ChatGPT has been applied to such activities as marketing-content drafting, idea brainstorming, after-sales services delivery, customer engagement increases, and more [27].

The number of results obtained on the studied issue in knowledge databases indicates that several months have passed since the implementation of ChatGPT by OpenAI to the time this bibliometric analysis was performed. Upon revisiting bibliometric analysis in a 2024 post-research implementation, a notable research gap persists, marked by a scarcity of publications addressing both ChatGPT implementation and business-process management (BPM). In the Web of Science database (March 2024), merely one publication was identified for the query, with a similar trend reflected in Scopus, yielding only one result (March 2024). Despite a substantial increase in publications on ChatGPT, research avenues exploring its implementation potential in management methodologies like BPM remain underexplored, prompting the need for focused investigation.

3. Methodology

The empirical investigation was carried out using the participatory observation and unstructured interview methods, with the support of the CRISP-DM data-mining methodology [28] and process mining. At this point, it is important to emphasize that data analysis was conducted using a cycle associated with their exploration using the CRISP-DM methodology, traversing through the individual phases of the cycle (business understanding, data understanding, data preparation, modeling, and execution). To accomplish this, Excel for Mac, version 16.92, was utilized as the primary tool. The subject of the study consisted of automotive organizations in Poland, which had been drawn for the study using a non-probabilistic technique with purposive sampling. The selection criterion entailed the following: the possession of a concession for car maintenance and warranty servicing, membership in dealership network, and a classification of a minimum level three of a MMPM model process maturity [29]. First, the units were subjected to a maturity-level assessment, to confirm identification, formalization, and measurement, using the adopted key performance indicators (KPIs), of the business processes implemented in those organizations. This served as a supporting factor for process reproduction and analysis, based on the information on the date and time of the process task's execution. As a result, repair records for 405 completed warranty processes were collected to reconstruct the after-sales service process. The main task in this part of the empirical investigation was to develop a

database of event logs, to explore the process investigated, and its stages. The course of the scientific and research process was divided into eight stages, characterized in Table 2. The data presented in Table 2 is relevant to the research question as it pertains to the identification of the potential impact of implementing ChatGPT in automotive after-sales processes. This requires a detailed analysis of the process flow, the identification of areas with high levels of standardization, an extended duration of activities that could be replaced by automation, or improved efficiency through human–machine collaboration (human–ChatGPT). By examining the specific details and metrics presented in Table 2, such as the level of standardization, the duration of activities, and the potential for automation or collaboration, a comprehensive assessment can be made regarding the potential benefits and impact of ChatGPT implementation in different stages of the after-sales processes.

Table 2. Scientific and research process description.

Stage	Research Task/s	Research Method/s and Technique/s
Stage 1	Identification of the cognitive gap and formulation of the research question and study objective based on theoretical exploration of the gap and current knowledge regarding the application of ChatGPT in the studied sector.	Bibliometric analysis and literature review, which were based on three knowledge databases and utilized a query related to the keywords "ChatGPT" and "BPM".
Stage 2	Specification of the research-sampling technique and dealership selection criteria. The selection criteria included holding a concession for car maintenance and warranty servicing, being a member of dealership network X, and achieving at least level 3 BPM maturity in the MMPM model process maturity.	Overview of literature on the non-probabilistic technique and purposive sampling. The non-probabilistic sampling technique employed in this study involved the purposeful (non-random) selection of units. The selection criteria primarily focused on units (dealerships) that exhibited a level of BPM maturity corresponding to the level at which processes were measured, and event data were either digitized or recorded in the documentation. This criterion facilitated the reconstruction of process flows and the identification of areas for improvement.
Stage 3	Maturity-level verification. Identifying BPM maturity using a research questionnaire based on the MMPM.	Structured interview, using a business process maturity-assessment tool (MMPM model).
Stage 4	Analysis of after-sales service documents, including warranty policies and technical documentation. Designing an after-sales process database based on available procedural documentation and reconstructing action sequences with employees of the surveyed units. Compiling an event logs database from the analyzed documentation.	Participant observation. Process mining.
Stage 5	Analysis of after-sales service documents, including warranty policies, service orders, warranty claims, and technical documentation. Designing an after-sales process database based on available warranty documentation and reconstructing action sequences with employees of the surveyed units. Compiling an event logs database from the analyzed documentation. Assessing the quality of the obtained data based on the documentation and verifying the data with automotive sector experts. The evaluation of data quality considers not only data gaps but also inconsistencies. Process documentation from the surveyed units was compared with processes reconstructed using process-mining techniques.	CRISP-DM methodology

Table 2. *Cont.*

Stage	Research Task/s	Research Method/s and Technique/s
Stage 6	Analysis of the after-sales process, expanding it using the created event logs database.	Process mining
Stage 7	Selection of the experts and discussion of the results obtained (mapping the course of the process investigated and activity-implementation timing).	Unstructured interview
Stage 8	Identification of the ChatGPT implementation potential in the examined group of processes. Formulation of conclusions, limitations, and further research directions.	Process mining

Source: own elaboration based on the study carried out in 2023.

Each stage contributes to the overall understanding of the research question by addressing specific aspects of the implementation and impact of ChatGPT in the context of automotive after-sales processes. The first stage involves identifying the cognitive gap and formulating the research question and study objective. This initial step sets the foundation for investigating the potential impact of ChatGPT and defines the scope of the research. The second stage focuses on specifying the research-sampling technique and dealership selection criteria. By carefully selecting the samples and dealerships, the study aims to gather relevant data that can provide insights into the potential impact of ChatGPT at specific stages of the after-sales process. The BPM maturity-level verification constitutes the third stage, assessing the readiness and applicability of BPM in automotive after-sales processes. This evaluation helps determine the feasibility of implementing BPM and ChatGPT's (AI's) potential impact. The fourth stage involves analyzing after-sales service documents, designing an after-sales process database, and compiling event logs. These activities facilitate a comprehensive examination of the potential impact of ChatGPT by studying relevant data and capturing process-related information. Data quality analysis, the fifth stage, ensures the reliability and validity of the collected data. This step is crucial for drawing accurate conclusions regarding the potential impact of ChatGPT on automotive after-sales processes. The sixth stage entails an in-depth analysis of the after-sales process, considering factors such as efficiency, customer satisfaction, and cost-effectiveness. By examining specific stages of the after-sales process, the study aims to determine the potential benefits and drawbacks of implementing ChatGPT. Expert selection and discussion form the seventh stage, where experts' insights contribute to mapping the investigated process and activity-implementation timing. Their expertise enriches the understanding of ChatGPT's potential impact and provides valuable input for analysis and interpretation. In the final stage, the research identifies the potential for ChatGPT implementation in the examined group of processes. Conclusions are formulated, limitations are acknowledged, and further research directions are proposed to extend our knowledge on the impact of ChatGPT in automotive after-sales processes.

During the expert interviews stage, they were asked to review the process flow maps (reconstructed using process mining) presented to them. Subsequently, the experts were requested to confirm their tenure in the automotive sector in the after-sales and warranty-service areas. For each specific action, experts were asked to indicate, based on their experience, what the reference duration in minutes for each stage of the process should be. Then, the provided values were compiled for the selected process, and the times obtained from process-mining analysis were presented, indicating descriptive statistics values: mean and median. After presenting the times, experts were asked to comment on the reasons or deviations in the implementation of individual activities. During the discussion, experts' statements were recorded, and they did not consult each other's responses.

Figure 2 shows the structure of the databases used to compile the research database, based on the resources of which the event logs for the set of the after-sales processes investigated were generated.

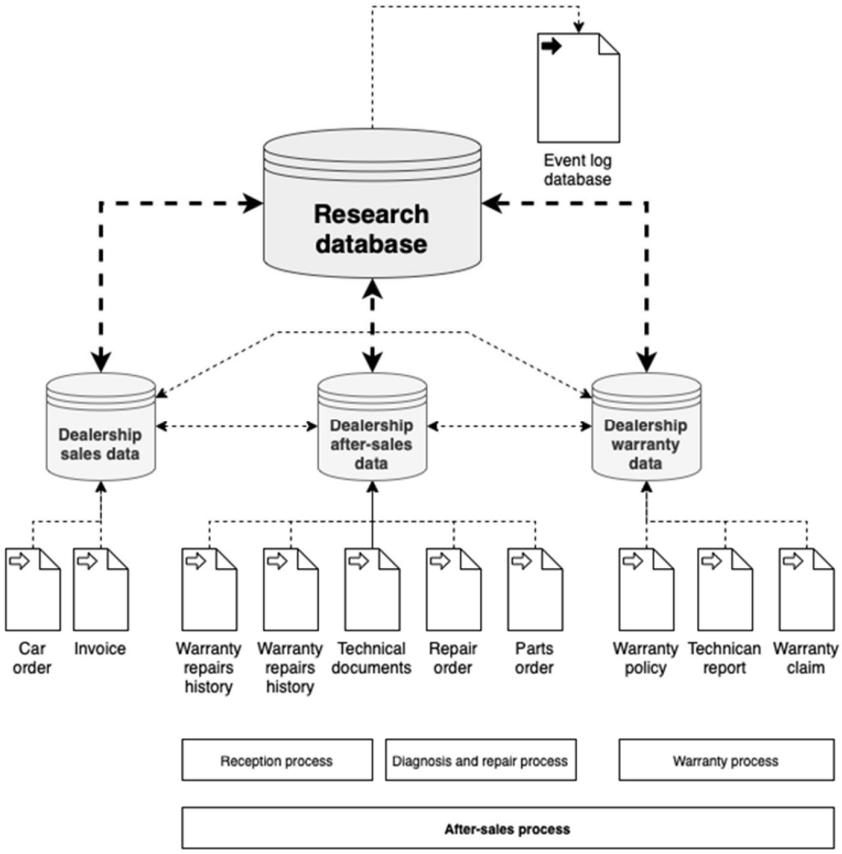

Figure 2. Structure of the data in dealerships in the automotive sector. Source: Based on the work of [30].

The research database developed enabled the generation of an event logs database, which was analyzed using CELONIS SNAP software. The structure of the event logs database contained variables, which enabled the exploration of the set of processes under study, using the CELONIS Snap tool. Table 3 shows the record structure in the event logs database.

Table 3. Exemplary activities in the event logs database used in the study.

ID	Dealership_ID	Mileage	Activity	Actor	Timestamp
O12_60	O_02	10,022	Reception check-out	Service advisor	27 March 2015 13:55
O12_60	O_02	10,022	Repair end	Technician	27 March 2015 13:00
O12_60	O_02	10,022	Part transfer to workshop	Parts advisor	27 March 2015 12:04
O12_60	O_02	10,022	Repair start	Technician	27 March 2015 11:00
O12_60	O_02	10,022	Service reception	Service advisor	27 March 2015 9:41
O12_60	O_02	10,022	Repair order printed	Service advisor	27 March 2015 9:40

Source: own compilation using Excel for Mac version 16.82 (Office 365) based on the author's own study.

The database generated yielded data on the process under study for 405 cases. It should also be emphasized here that the quality analysis of the data obtained did not reveal any errors, hence all the repairs selected for the study were included in the after-sales process analysis.

4. Results

4.1. Quantitative Study via Process Mining

Figure 3A shows the process flow for 95.6% of activities and 81.3% of connections. Figure 3B, in turn, shows a diagram for 100% of activities and 83.9% of connections. This

group is discernable by activities involving repairs requiring the delivery of parts (part transfer to the workshop) and computer-diagnostics implementation (diagnosis test start and diagnosis test end). The selection of the number of activities and connections was adjusted, to increase the readability of the map and extend the analysis, in terms of the potential of ChatGPT implementation, by adopting the parameter of process-execution time.

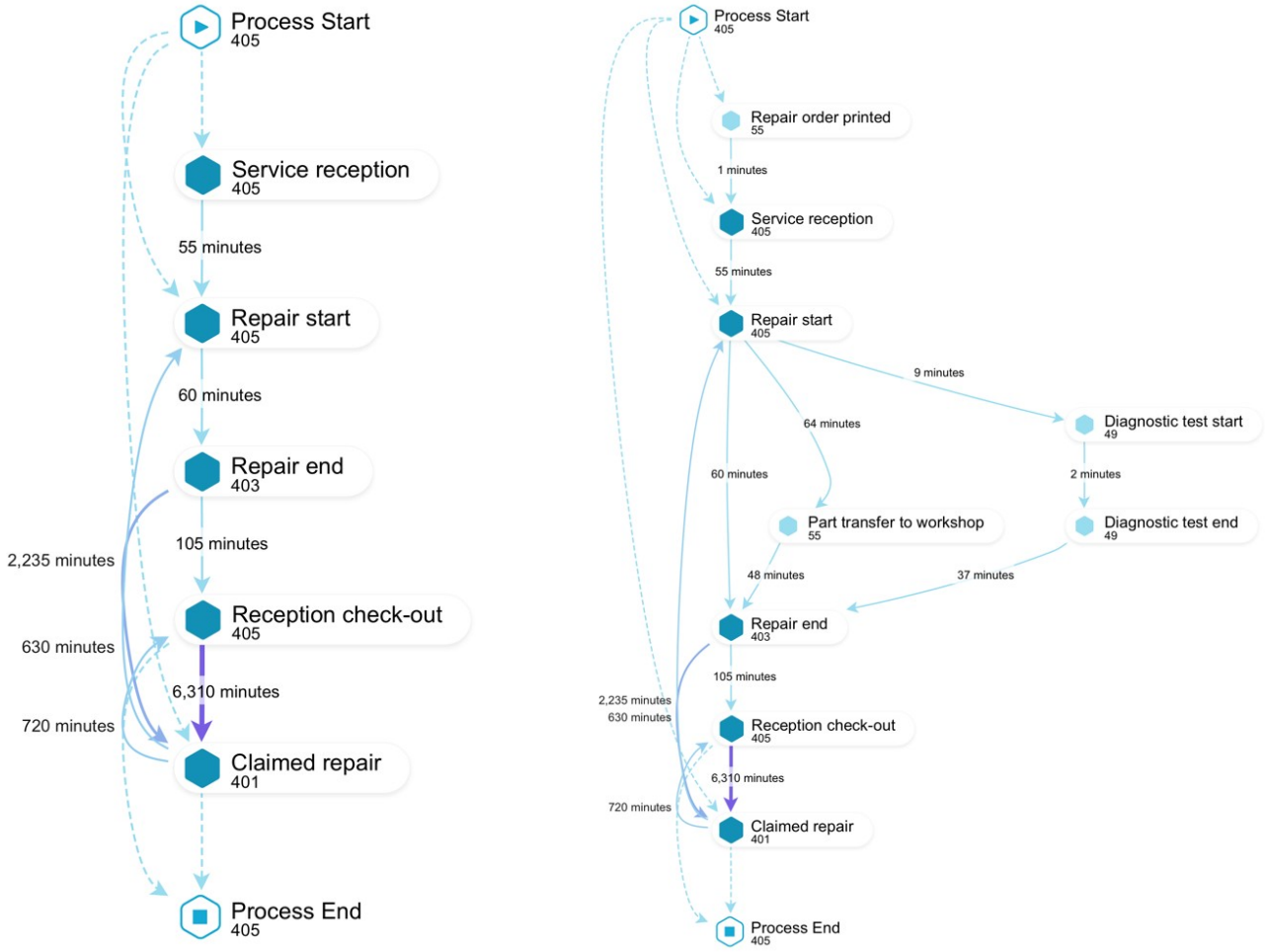

Figure 3. The course of the investigated after-sales process. Source: own study using CELONIS SNAP.

Moving forward, the focus was shifted to the overview process. Attention was first drawn to the happy path (Figure 4). In the case under investigation, the process-mining term 'happy path' refers to the most common flow of the after-sales process events. A happy path (happy flow) is the sequence of the activities expected to occur in a process, performed without any deviations or interruptions, and represents the optimal path through a given process under study [31]. Only 45.68% of cases exhibited a happy path, which accounts for 185 of the 405 cases under examination, with happy path throughput time = 11 days.

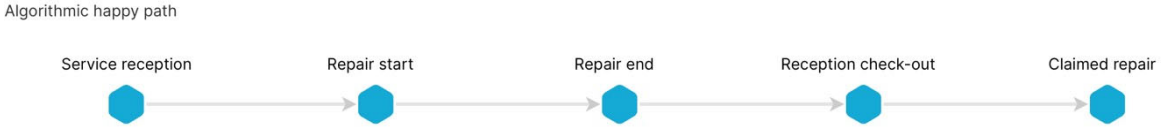

Figure 4. Happy path of the studied after-sales process in the organizations studied, N = 10. Source: own compilation using CELONIS SNAP.

The happy path shown in Figure 4 does not include such activities as part transfer to the workshop (in 14% of cases, 55 events), repair order printed (in 14% of cases, 55 events), or diagnostic test start and end (12% of cases, 49 events). Based on the happy path, the optimal flow of events in an after-sales process was identified. On this basis, an attempt was made to identify the areas of improvement with the use of the ChatGPT tool. The business-process parameter factored in was throughput time. Subsequently, an attempt was made to analyze the throughput time (TPT) of the process under study. Since both the date and start time of activities were included in the event logs database, the values in the graphs are given in hours. Drawing on the sample of 405 repairs, the median throughput time, from the beginning to the end of the process (i.e., from the acceptance of the customer's request to the submission of the warranty claim to the manufacturer's system) was found to be 114 [h]. It is worth noting here that an active claim should be equated with the activity of issuing the customer an invoice. Within the set of the processes under examination, focus was given to those the execution of which exceeds 114 [h].

Figure 5 shows the characteristics of the process investigated, from the perspective of throughput time analyses, and so the average = 239 [h], maximum = 9928 [h], and minimum = 8 [h]. A middle value (median) was also adopted in the study.

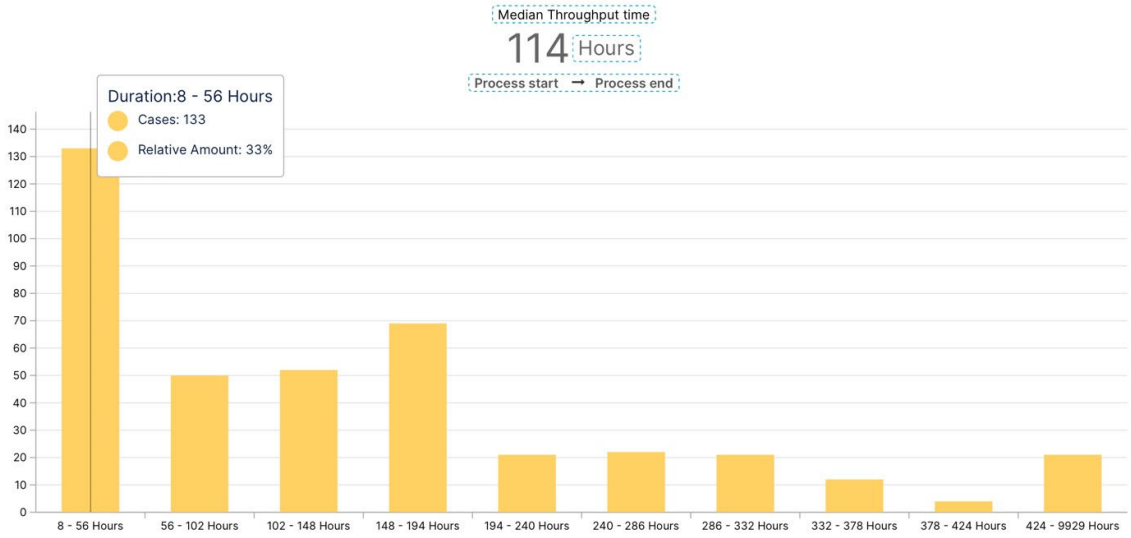

Figure 5. Throughput times (TPT) of the after-sales process under examination, N repairs = 405. Source: own compilation using CELONIS SNAP.

The process mining has led to the following findings: 405 cases, corresponding to 90 variants, were examined; first variant = 46% of cases, which is also the conformance ratio, 20% variants cover~80% cases, median TPT = 114 [h], min TPT = 8 [h], max TPT = 9929 [h], and no rework (rework rate = 0).

Given the activity-execution-time data (median) for the process under investigation, Figure 6 illustrates the areas exhibiting potential for ChatGPT implementation.

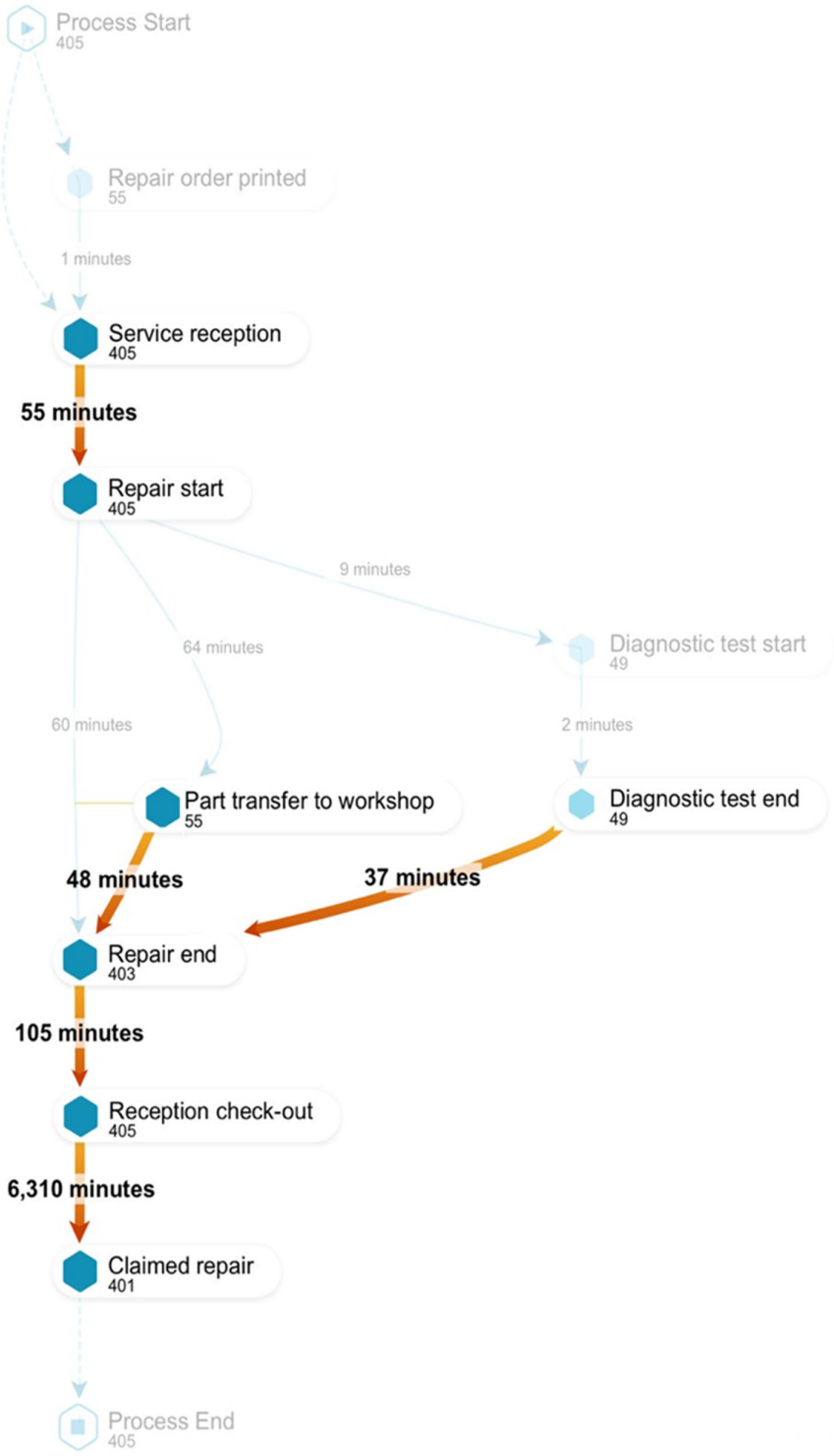

Figure 6. Identification of process stages with high potential for ChatGPT implementation. Source: own study using CELONIS SNAP.

4.2. Results of Qualitative Survey with Four Automotive Sector Experts

The process-mining results obtained, including the happy path given in Figure 4, were shared with four selected experts. The decision to include four experts in the study was justified by several factors. The main criterion for expert selection was their seniority of more than 5 years in the automotive sector. Additionally, the experts were chosen based on their affiliation with the units under examination, including both managerial and specialized employees. One of the experts was also an employee of an external consulting

firm specializing in warranty audits in the European automotive sector. By including these four experts, this study aimed to incorporate diverse perspectives and experiences related to automotive after-sales processes. This approach allowed for a comprehensive understanding of the subject matter and facilitated the gathering of valuable insights, observations, and conclusions regarding the potential impact of ChatGPT implementation in the after-sales processes. In this context, it is imperative to underscore that the selection of experts, in terms of criteria and quantity, has been grounded in the seminal work of Crispen and Hoffman [32].

This enabled the assessment of the process under examination and the reasons for the extended lead times of the activities shown in Figure 6, from the perspective of both the dealership and the car manufacturer's representative. The survey with the experts was implemented in 2023.

First, the experts were introduced to the types of repairs under analysis, as well as the after-sales service requirements and standards in the surveyed group of units. The experts surveyed unanimously emphasized that the after-sales process investigated is heterogeneous in nature and its course is primarily determined by the type of fault, the degree of support from the manufacturer's engineering and warranty department, and access to technical documentation. According to the experts, the after-sales process should be categorized into types of intervention. In the author's opinion, this proposal would be difficult to implement at this stage of the study, due to the large number of fault-cause codes. The suggestion made by the experts provides a platform for future research covering three types of services: inspection and maintenance, the implementation of servicing actions, and repairs.

The experts were then presented with the maps shown Figure 3A,B and asked to indicate the nominal (reference) duration of each activity in the process. It is worth noting here that the values (medians) obtained for the execution time of the activities in the process have been concealed in the maps presented. The results are shown in Table 4.

Table 4. Overview of process-mining-derived activity-execution times and expert assessments.

Activity	Expert				Experts' Mean Time	Mean in the Process under Study	Median in the Process under Study
	1	2	3	4			
	Minutes						
Service reception -> Repair start	30	25	35	25	29	5060	55
Part transfer to the workshop -> Repair end	Difficult to determine. Depends on the type of repair.					47	48
Diagnostic test end -> Repair end	Difficult to determine. Depends on the type of repair.					51	37
Repair end -> Reception checkout	45	30	30	20	31	1134	105
Reception check-out -> Claim repair	1200	1500	2400	3000	1775	7066	6310

Source: own compilation using CELONIS SNAP, based on the study carried out in 2023.

In this context, it is important to underline that the number of experts participating in the qualitative study was primarily determined by availability and willingness to engage a greater number of experts. Due to the declaration of only four experts during the execution of the study, shortly after the launch of ChatGPT, it was decided to proceed with the study in order to capture the moment a few months post-deployment of the tool. This means that

experts could not be onboarded at later stages, due to, for instance, the increasing level of ChatGPT operationalization, which, on one hand, provides grounds for repeating this study and comparing results with a significantly larger group of experts. It is also worth emphasizing that the selection criteria allowed for a holistic view of the problem under study, taking into account participants representing diverse organizations in the sector being studied, thus providing different perspectives on the same process. Moreover, the level of standardization of this process applies to most car manufacturers, which means that, due to this level of process repeatability, increasing the number of experts may not yield the same effect as if it were a sales process, characterized by lack of structure and its course being highly determined by factors such as the customer, segment, current sales policy, advertising campaigns, and promotions, as well as campaigns promoting alternative propulsion methods, for example.

As Table 4 shows, the largest deviations are discernable for such activities as service reception -> repair start (time from the reception of a customer request to the start of the repair).

A process map was then presented to the group of experts (Figures 3A,B and 6), along with the median values of individual activity execution. During the interview, the experts were asked to provide information regarding the possible reasons for the extended time in the group of the processes under examination. The results of this part of the survey are shown in Table 5.

Table 5. Results of the qualitative study carried out using the expert interview method.

Activities	Expert 1	Expert 2	Expert 3	Expert 4
	Service Manager (Seniority > 15 Years)	**Service Advisor (Seniority > 10 Years)**	**Workshop Manager (Seniority > 5 Years)**	**Warranty Auditor (Seniority > 5 Years)**
Service reception -> Repair start	Customers ask questions which are included in the vehicle's service book. It should also be noted that there are times when customers do not arrive at the appointed time and thus the technician cannot begin work.	Customers ask for servicing on the day of arrival at the service center. The reception desk, despite the standard, does not always check the actions at the time of appointment reservation by the customer. The large number of minutes between acceptance and repair may result from the fact of receiving the car being in the morning, for example, while the repair is scheduled for the afternoon.	We receive too little information about the defect, which makes its identification a time-consuming task. Additional test drives are needed because of this.	In authorized car service centers, despite the standards, not all information is collected from customers at the time of making an appointment for a repair or inspection.
Part transfer to the workshop > Repair end	The search for repair instructions incidentally takes time. We have to carry out warranty repairs in accordance with the manufacturer's guidelines, which is why the technician checks and prints the repair documentation after the parts are released.	Problems with choosing the right repair manual. Not all technicians complete documentation at the diagnosis stage, but rather after receiving the parts.	Limited number of computers, in terms of repair manual and/or technical bulletin search. Internet connection problems emerge at times. The biggest problem in this regard is with new employees, who are not familiar with the systems.	Car service shops do not comply with the standards of repair preparation. Repair documentation should be prepared already at the time of ordering the parts needed to fix the defect.

Table 5. *Cont.*

Activities	Expert 1	Expert 2	Expert 3	Expert 4
	Service Manager (Seniority > 15 Years)	**Service Advisor (Seniority > 10 Years)**	**Workshop Manager (Seniority > 5 Years)**	**Warranty Auditor (Seniority > 5 Years)**
Diagnostic test end -> Repair end	The paperwork and bureaucracy involved warranty repairs. The document and report filling out takes more time than the repair in some cases.	In order to meet the requirements of the manufacturer and warranty audits, multi-page repair documentation needs to be compiled, which takes a considerable amount of time.	Diagnosis results need to be checked against the manufacturer's documentation. Every error (error code) should be checked against the documentation.	The car-service shops' technicians have to search for solutions to selected codes provided by diagnostic devices. Depending on the repair, some codes refer to specific documentation, while others necessitate a deeper search for errors.
Repair end -> Reception check-out	The technician must complete the repair report before handing the car over for release.	It is possible that this time range also includes vehicle washing, which is not recorded by many service centers. This means that the time of entering the car wash and completing the task is not recorded on the repair order.	Technicians must compile reports for repairs performed under warranty. Without the inscriptions required by the manufacturer, warranty repairs cannot be claimed. When the descriptions are incomplete, the manufacturer may also refuse to pay for the repair performed.	It is difficult to assess the time range. It would be useful to have additional information regarding the time of the car handover to the service advisor and the car wash, or to make records of such inspection activities as test drives. Keeping records of quality control as part of repair labor time is a standard for some car brands.
Reception check-out -> Claim repair	The time devoted to compiling the repair documents is unpaid. Particularly expensive repairs, e.g., engine, engine controller, transmission, etc., require a very large number of documents and reports to get the repair accepted and paid for.	Too much information is required to claim a warranty repair. It should be simple enough for any service advisor, as opposed to the need for a highly qualified specialist.	Due to the need to comply with the manufacturer's standards and warranty policy, each claim is checked times, requiring the participation of employees from different departments.	The execution of warranty audits does not verify the claim-settlement time. There is an upper limit for claim submission. Usually, dealerships first perform the repairs, and only later the repair report is compiled. This is due to the complexity of justifying a warranty repair for claiming purposes.

Source: own compilation based on the expert interviews carried out in 2023.

Given the process parameter adopted (lead time), drawing on the process-mining analysis and the result of the expert interviews, the following four activities were adopted to assess the potential of ChatGPT: service reception, reception check-out, repair and maintenance process, and claim repair.

It should be emphasized here that, based on the data and expert opinions collected, this article does not attempt to assess ChatGPT in terms of repair-related processes. Due to the variation in the scope of the repairs, an assessment based on the data at hand would be too superficial.

Based on the insights gained from expert interviews and the provided table, the potential for implementing ChatGPT in the after-sales service process appears promising. The delineated potential for ChatGPT implementation spans three distinct areas, reflecting applicability not only within the examined industry sectors but also affirming the tool's viability in the specified operational domains of the studied entities. Firstly, within the domain of the service reception process, notable prospects involve customer-service enhancements and the integration of chatbots [3,33]. In the automotive service reception phase, ChatGPT can automate initial customer interactions, providing relevant information from the vehicle's service book and assisting with appointment scheduling. It can streamline the process by collecting necessary details about the defect upfront, thus improving efficiency and ensuring comprehensive data collection. Secondly, in the execution of reception check-out,

the potential aligns closely with the preceding realm, focusing on after-sales' customer service and aiding with daily work [3]. This pertains to activities of high standardization, encompassing tasks such as preparing estimates, providing explanations regarding repair executions, and offering recommendations for vehicle operation. In this context, ChatGPT assumes roles delineated in the literature [3]. In the third area, encompassing the claim-repair phase of the warranty process, the potential is articulated within the analysis space of utilized parts, part and labor compliance with the technician's report, and the verification of the appropriate part catalog numbers based on the electronic repair instructions. These aspects align with the roles attributed to ChatGPT, as indicated in the study [3]. It is noteworthy to emphasize the potential within the claim-repair context for conducting internal audits of warranty processes [34].

During the repair start, ChatGPT can assist service advisors in performing standardized checks and actions during the appointment reservation process. It can support in ensuring that customers arrive on time, promptly notify technicians of any delays or changes, and gather more detailed information about the defect from customers [35]. This reduces the time-consuming task of defect identification and facilitates a smoother repair initiation. In the subsequent phases of part transfer to the workshop and repair end, ChatGPT can support technicians by simplifying the search for repair instructions and manuals. It ensures that the correct documentation is readily available at the diagnosis stage, helping technicians choose the appropriate repair manuals and technical bulletins. By eliminating issues caused by limited computer access or internet connectivity, ChatGPT improves efficiency and adherence to repair standards. During the diagnostic test end to the repair-end phase, ChatGPT aids technicians in cross-referencing diagnostic results with the manufacturer's documentation. It provides solutions or suggestions based on error codes, reducing the need for extensive manual searching and expediting the repair process. Furthermore, in the repair end to reception check-out phase, ChatGPT assists technicians in completing repair reports accurately and efficiently. It ensures that all necessary information is included, facilitates a smooth handover of the vehicle, and helps in recording additional activities such as vehicle washing and test drives, ensuring accurate time tracking and quality control. Finally, in the reception check-out to claim-repair phase, ChatGPT simplifies the process of compiling repair documents and reports. It reduces the burden on service advisors, as it provides guidance on the information required for warranty claims. This streamlines the claim-submission process, ensuring a smooth and efficient workflow.

5. Discussion

The obtained results from both quantitative and qualitative research illustrate the potential for implementing ChatGPT within the scope of this study. It is noteworthy that the collection of 405 cases from the after-sales process is significant from the perspective of organizations in the automotive sector. The level of complexity of the after-sales process aligns with observations made by other authors [36], who analyzed it from a process-management perspective. Expanding on other studies, it has been indicated that the examined process consists of several subprocesses (e.g., the customer acceptance process, fault diagnosis and verification process, repair process, part-ordering process, technical documentation verification and technical-department contact process, quality-control process, and the warranty service process). This implies that while the process is highly standardized on one hand, on the other hand, as evidenced by the conducted process-mining study, numerous deviations are observable, necessitating consideration from various perspectives. In this article, the focus was on the time of execution, but equally significant are aspects of efficiency and effectiveness, as described in the work by Grajewski et al. [37]. It is worth emphasizing that the result of these parameters is the aspect of customer satisfaction, a key metric from the perspective of the investigated issue [38].

From the customer's standpoint, prolonging the after-sales process extends the lead time, consequently resulting in waiting time becoming an unnecessary cost of service

delivery for the customer. The aspect of customer satisfaction in the after-sales process is not only emphasized in this article but is widely discussed in the literature as a cognitive object aimed at improving service provision [39–42]. This underscores the potential for transformation toward an end-to-end approach. According to Hammer and Hershman [43], an end-to-end business process focuses on the high-leverage aspects of an organization's operations to gain a competitive advantage and achieve better results. In the author's perspective, the set of activities in question can be defined as a "from-complaint-to-claim" process, particularly concerning repairs performed under the manufacturer's warranty, while other repairs entail a "from-complaint-to-cash" process. The starting point for modeling such a process, which marks the orientation of further research, is the happy path shown in Figure 4, serving as a reference representation of the process explored in this article.

The issue of reliability presents a significant knowledge gap. Through the literature review, only a small number of publications dedicated to this topic were identified. Three distinct studies were conducted to investigate the reliability of ChatGPT. The first study, conducted by [44], aimed to measure the reliability of ChatGPT in a general question-answering scenario. The study meticulously curated a set of 5695 questions from ten datasets and eight domains. The authors found that ChatGPT's reliability varies across domains, particularly underperforming in law and science questions. They also demonstrated that system roles, originally designed by OpenAI to allow users to control ChatGPT's behavior, can impact its reliability. Additionally, the study showed that ChatGPT is vulnerable to adversarial examples, and even a single character change can negatively affect its reliability in certain cases. This study provided valuable insights into ChatGPT's reliability and highlighted the need to strengthen the reliability and security of large language models. The second study, conducted by Reiss (2023), focused on examining the consistency of ChatGPT's zero-shot capabilities in text annotation and classification. The author emphasized that ChatGPT is non-deterministic, meaning that identical inputs can lead to different outputs, similar to human coders. Summing up the results of this study primarily revolves around the potential implementation of ChatGPT in managing the examined process, focusing on optimizing its course in terms of the time required for the entire process, and more specifically, for individual stages. On one hand, it is essential to consider that while the accessibility of tools like ChatGPT is very high, changes proposed by this artificial intelligence tool should not be implemented reflexively. Additionally, ChatGPT requires training data specific to the business domain, potentially resulting in inaccurate and unclear outcomes [45]. However, these opportunities have not been systematically investigated. This aligns with the presented research constraints and indicates directions for further inquiry. This article delves into how this tool can be leveraged at the level of the examined process, taking into account its limitations.

It is crucial to highlight that the research findings are supported by current publications affirming the potential of ChatGPT in optimizing processes or activities, both quantitatively and qualitatively. The issue of time reduction has been emphasized in other works, addressing the main challenges and enhancing the efficiency of the Gcode-generation process in Additive Manufacturing [46] and in the medical industry [47]. Additionally, the identified areas for potential ChatGPT implementation in the examined process align with the results of [45], where the authors underscored that the top benefits of ChatGPT include enhanced customer engagement, quick and informative responses, personalized interactions, human-like text generation, automated tasks, and a more positive customer experience.

Based on the literature [48–51], experiences with ChatGPT utilization, and the research findings, it is evident that the limitations stem from the need for extensive training data, challenges in standardizing diverse repair cases, concerns regarding data security, the potential loss of personalized customer service, and the inherent complexities of repair processes. These insights underscore the importance of thorough assessment and adaptation to mitigate risks and maximize the benefits of ChatGPT integration in after-sales processes.

6. Conclusions

ChatGPT is a type of a language model developed by OpenAI, which uses advanced artificial intelligence algorithms to generate human-like text. Because of its ability to optimize certain activities and process stages previously performed by humans, ChatGPT can be a game changer in the field of BPM. Considering the after-sales process investigated, this includes activities, the execution time of which could be reduced to reference values (experts various). This research identifies the prospect of a from-complaint-to-claim process (end2end process), particularly in repairs performed under the manufacturer's warranty, and elucidates the nuances associated with warranty verification, adherence to manufacturer's standards, and the overall settlement process. The research findings revealed a process's transformative potential in leveraging ChatGPT for process improvement and/or optimization, particularly in enhancing efficiency, reducing wait times, and augmenting customer satisfaction. Through an analysis of after-sales processes, such as service reception, check-out, and warranty-claim processing, the study illuminated the specific areas within which it can support in response to the formulated research question regarding the potential role of implementing ChatGPT in streamlining after-sales processes in the automotive sector, particularly in terms of reducing process-completion time. The potential of ChatGPT implementation manifests in the tool's ability to enhance operational efficiency, customer satisfaction, and overall service quality. By deploying ChatGPT at specific stages such as service-request handling, transaction processes, maintenance and repairs, and complaint resolution, the tool can contribute to minimizing unnecessary time delays and expediting the entire process. The study emphasizes that the implementation of ChatGPT, particularly in the context of service delivery, can lead to a reduction in lead time, thus mitigating unnecessary costs.

6.1. Managerial Implications

The study results presented supply new knowledge about the development of business-process management, in terms of implementing modern AI-based IT technologies, tools, and techniques to support process execution. It is worth noting here that the cost of ChatGPT use depends on various factors, including the size of the model, the number of API requests made, and the specific use case. From the perspective of managerial implications, it is crucial to emphasize that the potential implementation of ChatGPT for improving and optimizing business processes in the automotive sector is primarily contingent on the BPM maturity level. This implies that the ability to identify processes, their stages, or individual activities necessitates achieving a level of BPM maturity where processes are identified, formalized, and measured. The proposed utilization of process mining is also conditioned by the imperative need for data digitization related to the executed processes. This digitization is crucial for building an event log based on event data and employing process-mining tools effectively.

6.2. Research Limitations

Like any such research, this study too has its limitations. They are primarily related to the non-probabilistic technique of research-sample selection, which enables inference into the examined group of dealerships only. It is also important to note that the low level of event digitization in the process under examination prevented detailed assessment, in the empirical layer, of such process stages as contact with the manufacturer's technical and warranty departments, the waiting time for parts, the time to transport parts, or the time of warranty-claim clearance. Additionally, it should be emphasized that the study's concentration on the automotive sector was dictated by experts' accessibility; nevertheless, this constraint serves as a springboard for future expanded research encompassing various industry sectors. The selection of the automotive sector as the focus area was also guided by a literature review, wherein the potential for implementing process mining in after-sales was recognized and researched [52–54]. Moreover, it is worth noting that in 2024, the

number of tools similar to ChatGPT is on the rise. This trend, in the context of expanding research, will enable the identification of differences and similarities among these tools.

A limitation of this study is the participation of only four experts in the qualitative investigation. While this quantity may seem limited from a quantitative perspective, it is essential to emphasize that the criteria used for their selection ensured a broad spectrum of perspectives on business processes, particularly given the high level of standardization in the studied sector. Moreover, a similar number of experts has been employed in other scientific studies [55].

6.3. Future Research

The research limitations outlined have set the direction for further research. The author's goal is, first, to increase the number of surveyed units and, using participant observation and a detailed analysis of service documents, develop a more detailed event logs database to identify areas of high potential for the implementation of ChatGPT and Robotics Process Automation (RPA) technologies, including the identification of the process steps in which such activities are not possible. The study can also be complemented by an analysis of customers' email content, in order to assess the capabilities of ChatGPT, in terms of automatic responses to after-sales customer inquiries.

Upon concluding the manuscript, a discernible increase in the number of publications related to ChatGPT becomes evident. In addition to the operationalization contexts discussed earlier, it is noteworthy to consider the work by Bush et al. [56]), which broadly presents the potential utilization of ChatGPT in business-process management (BPM), including aspects such as predictive process monitoring and process extraction from text. The heightened operationalization of ChatGPT within organizations also generates a developmental direction in research, considering aspects such as employee engagement, leadership, process optimization, and process management. This development is evident in publications such as the one by Vrontis et al. [57], highlighting the crucial role played by both ChatGPT and skilled workers in enhancing business sustainability. Additionally, Frederico [58] suggests that ChatGPT can serve as a significant tool supporting supply chain management. The supply chain aspect aligns broadly with BPM, and, hence, future research will consider the potential for improving processes using ChatGPT not only within individual processes but throughout the entire architecture of business processes within an organization, including the consideration of interorganizational processes.

Analyzing the structure of the studied after-sales and warranty processes, in the author's opinion, should be the direction of further research, which may also concern related sectors where such processes are implemented. This means that the presented studies can be expanded not only in the automotive sector but also in sectors such as agriculture, construction machinery, and aviation.

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