Fundamental Framework for Task Mining Technology Adoption

Results from a Qualitative Empirical Study

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ABSTRACT

Digitalization influences business processes and their management. Digital technologies such as Process Mining (PM) or Robotic Process Automation (RPA), which are becoming more and more prevalent, offer new possibilities for process analysis, monitoring, and automation. PM can further be helpful in identifying processes that are suitable for RPA. However, purely applying PM at the business data level often does not produce all the details required to assess RPA suitability. These necessary details can be supplemented by Task Mining (TM), a technology that can analyze tasks at a desktop data level, which opens further potential beyond the automation benefits. However, the currently available scientific literature on TM is scarce and empirical qualitative studies or case studies on the adoption of TM technology from a BPM perspective are missing. Therefore, this paper develops a fundamental framework for TM technology adoption based on a qualitative empirical study involving experts via semi-structured interviews, which are analyzed according to the qualitative content analysis based on the methodology of Mayring. The framework relates five potential benefits, two opportunities, four risks, and four basic requirements identified from the qualitative study. It thus provides a new valid starting point for future research efforts and serves as a guideline for managers in practice to evaluate a potential TM deployment in the company.

CCS CONCEPTS

• **Task**; • **Mining**; • **Framework**;

KEYWORDS

Task Mining Technology, Framework, Qualitative Study, Business Process Management, BPM, Robotic Process Automation, RPA, Process Mining, Empirical Study, Semi-structured Interviews

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1 INTRODUCTION

By using digital technologies, companies can improve performance and generate competitive advantages. [1], [2] Therefore, the European Union (EU) is striving to drive forward the digitization of companies based on the targets of the 2030 Digital Compass. By 2030, 75 % of companies are supposed to use the cloud, Artificial Intelligence and Big Data technologies, and 90 % of SMEs to have at least a basic level of digital intensity. The Digital Economy and Society Index (DESI) 2022 reveals the prevailing digitization gaps indeed. In 2021, for instance, only 55 % of SMEs boasted a basic level of digital intensity. In contrast, however, a slight upward trend can be observed: Big Data is used by 14 % of companies in 2020 compared to 2018 (12 %). [3]

This increasing digitization influences business processes and their management. Digitized processes, for example, offer efficient monitoring options on the one hand and can be automated on the other. [4] An emerging digital technology to automate business processes is Robotic Process Automation (RPA). [5], [6] In a recent Capgemini IT trend study, 53.7 % of the participating companies already use or are currently implementing RPA. This puts RPA in second place after Container Technology (72.6 %), ahead of Machine Learning (42.3 %) and further 27 other IT trends surveyed in 2022. [7]

RPA automates rule-based recurring activities in IT systems currently performed by employees, such as the manual transfer of customer data from an Excel document to a CRM tool. This makes the range of RPA applications wide. Therefore, the challenge is to identify relevant processes with automation potential. For this purpose, processes are surveyed and examined to determine the extent to which they are suitable for automation. [8], [9] In such a process survey, conventional methods such as interviews, workshops or observations may reach their limits. On the one hand, the time required is high. On the other hand, they can be subjectively influenced, because they are performed by people. Finally, a complete collection of information is not possible or economically justifiable. [10] Conventional process survey methods for instance only record around 80 % of the possible variants. [11] In contrast, Process Mining (PM) is a digital form for discovering business processes. PM records a process based on information stored in event logs. Thus, PM can detect all process instances, whereby all variants can be uncovered. [9], [11], [12] With respect to RPA, it is apparent that purely applying PM at the business data level (for example, data from an ERP or CRM system) often does not produce the details needed to assess RPA suitability. These necessary details can be supplemented by Task Mining (TM), a technology that dives deeper into the processes. [13]

TM involves recording individual activities of an employee between web applications and desktop programs. Leno et al. (2021) define the recording of these interactions as User Interaction Logs (UI logs). One example is to select cells in a spreadsheet program, copy and paste content. Based on the UI logs, information about the daily routine of employees is collected. The collected variants are processed to obtain an improved process understanding at task level for the purpose of optimizing processes respectively derive automatable activities. [14] According to the PM market leader *Celonis*, TM can also contribute to the general assessment of labor productivity. [15]

Despite the mentioned application potential in process automation and productivity enhancement, the current available scientific literature still offers little information on TM. A query of the Scopus database in December 2022 with the search term "Task Mining" in the title and keywords results in only 3 publications. In addition, some relevant aspects for the evaluation of a deployment in the company from a Business Process Management (BPM) perspective – apart from RPA use cases as the following examples show – have not yet been examined intensively enough. Van der Aalst (2020) describes TM as a complement to PM to identify automatable processes and examines the Pareto principle in this context. [11] Likewise, Leno et al (2019) address which routines to automate first using RPA and explore Robotic PM. [14] Dumas et al. (2022) also use the term Robotic PM and refer to it as a TM use case. Even if RPA is in the center of their considerations, they also refer to the adoption of TM to identify differences in working methods and thus to improve tasks. They further address the use case that TM can be used to uncover inefficiencies in resource allocation. [16] Průcha and Skrbek (2022) use the term TM and describe it for the purpose of automating processes too. In their work, they explore the FURIA algorithm for improving TM. [17] Linn et al (2018) implement a TM proof-of-concept and go beyond the automation application by describing potential in process documentation, analysis, and optimization in an office environment. [18]

Although there is still little scientific literature on TM, the Everest Group is euphoric in its PEAK Matrix®Assessment regarding prospects: *"TM plays a key role in improving operational excellence, filling the automation pipeline, and accelerating organizations' digital transformation journey by providing a data-based approach to process optimization and automation. It is rapidly gaining traction across geographies and finding a wide range of use cases across business functions and verticals".* [19]

To summarize, in general scientific literature about TM is scarce and empirical qualitative studies or case studies on the adoption of TM from a BPM perspective are missing. Furthermore, except for the application in combination with RPA, few practical TM examples are described in detail. Moreover, although Everest Group for example highlights the role of TM in terms of process optimization and automation as well as its increasing traction, no study can yet be found on the diffusion of TM. Also, any privacy and surveillance concerns, such as those expressed for AI applications, need to be validated. [20]

Thus, from a scientific perspective, there is a lack of a comprehensive knowledge base and description of the research needs that should be addressed in scientific work on the topic. From the practice point of view, companies lack a solid basis for decision making to evaluate the adoption of TM. Therefore, this paper poses the following research questions (RQ) to contribute to TM as a research field in the BPM domain:

- RQ1 [Potential Benefits]: What are the potential benefits of TM adoption for companies?
- RQ2 [Opportunities]: What opportunities does TM technology offer?
- RQ3 [Risks]: What are the risks regarding TM?
- RQ4 [Dissemination]: What is the dissemination of TM?

Therefore, the aim of this work is to answer the research questions and develop a fundamental framework for TM technology adoption as a decision basis. Since there is still little scientific TM literature available and the work has an explorative character, a qualitative empirical approach is methodically pursued by means of semi-structured expert interviews. This method offers a detailed information gain, which is particularly valuable in new research areas and therefore appropriate for TM. [21]–[24] The object of investigation is represented by five companies – TM, RPA and PM providers, an RPA and PM consultant and one PM user – in which a total of 6 persons were interviewed. The analysis follows the qualitative content analysis according to Mayring [25].

Prior to the empirical part, the state of the art of TM is presented based on a literature review conducted to provide information on how TM works, different application areas and solution providers. This results in the following structure: section 2 describes the literature review, in section 3 the planning of the qualitative empirical study is explained, in section 4 the interview results and the framework are presented, and section 5 comprises the conclusion.

2 TASK MINING – STATE OF THE ART

The literature refers to TM also as "Robotic Process Mining", "Robotic Process Discovery" and "Desktop Activity Mining". In addition to the different terminologies, a uniform definition is absent. Therefore, this section firstly provides definitions and delimitations. Then, the procedure and functionality of TM is described. Furthermore, the application areas which are already taken up in the literature are described to be able to assess the potential novelty value of the results from the empirical part. Finally, existing solution providers are introduced.

2.1 Definitions

Leno et al. (2021) refer to TM as Robotic Process Mining (RPM) and define RPM as a model of techniques and tools that analyzes collected data, as users perform tasks in one or more software applications; predominantly to identify tasks that can be automated. [14] Reinkemeyer (2020) lists TM under the term "Robotic Process Discovery" (RPD) and describes the use case as better understanding how users work. [26] Linn et al. (2018) speak of "Desktop Activity Mining" and define it as a method in which user activities of desktop applications can be recorded and resulting process variants can be

Table 1: Exemplary excerpt from a UI log [19]

	UI time stamp	UI type	Payload1	PL2	PL3	PL4
1	2019-03-03T19:02:18	Open file (file system)	student_data.xls			
2	2019-03-03T19:02:23	Go to URL (Web)	https://www.industrial-management.at/iwi4u/			
3	2019-03-03T19:02:26	Click button (Web)	Industriewirtschaft			
4	2019-03-03T19:02:28	Select cell (Excel)	student_data.xls	Table1	A2	„John“
5	2019-03-03T19:02:31	Select field (Web)	https://www.industrial-management.at/iwi4u-iwi/	Username	Insert	„“

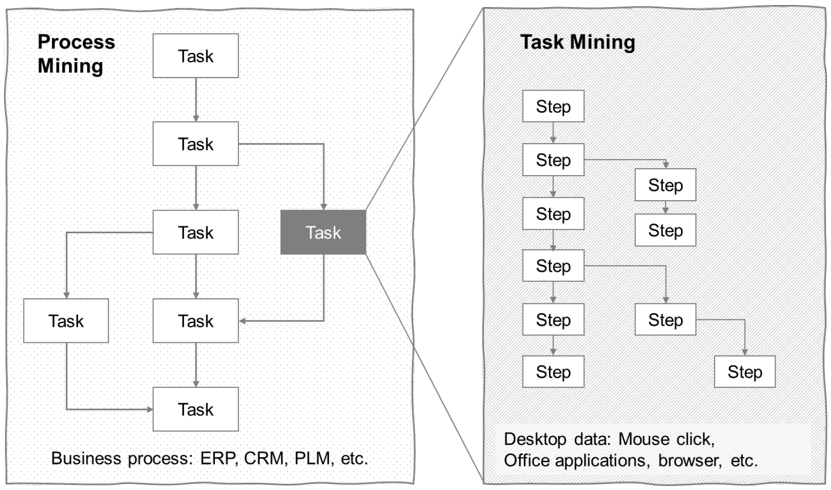

Figure 1: Complementing PM with TM [13]

comprehensibly summarized. [18] Van der Aalst (2020) uses the term TM and points out that this term is used by solution providers such as *Celonis* or *UiPath* when business data is completed with user interaction data. [11]

Indeed, the term TM can be found consistently among solution providers. *Celonis*, the market leader in PM, defines TM as a technology that enables companies to record user interaction data and subsequently analyze how users do their work or how they can improve it. [15] RPA market leader *UiPath* refers to TM as *"(...) a data-driven approach to gain deeper understanding of tasks employees perform on their desktops to identify process improvement areas and automation candidates."* [27] Since this paper focuses on the application of TM in practice the term TM will be used in the following. Furthermore, contrasting the previously mentioned definitions, this paper defines the TM as follows: *TM is a technology that collects and analyzes user interaction data from desktop applications to identify potential for optimization at the task level.*

In PM event logs – the log of the activities of the recorded processes [28] – are the data basis. Event logs are mostly extracted from so-called Process Aware information Systems (PAIS), because PAIS directly provide them. PAIS are systems as ERP or CRM that support the execution of entire processes and not only the execution of individual activities. [12] In contrast so-called User Interaction Logs (UI logs) are analyzed in TM. These are chronological records of activities users perform on the desktop in one or more software applications. [14] The following table shows an exemplary excerpt of a UI log.

Each row reflects a user activity such as a mouse click on a button or copying a cell. For each activity a timestamp, the type of activity and the payload is recorded. It is possible to record different payloads in the same UI log. For example, the table name and position of the target cell are documented in an Excel file, and the URL, HTML target and, if applicable, the content are documented on a website. [14], [16] In addition to records of mouse clicks, keyboard strokes, or field entries, there is also the possibility to store and analyze phone calls or email correspondences. Thus, TM complements PM with detailed information, as shown in Figure 1. [26]

The difference between the two technologies is particularly evident in the level of granularity. PM analyzes end-to-end business processes, such as a customer support process, while TM works on the detailed desktop level. [13]

2.2 Procedure and functionality

In the literature, TM is described in very general terms. Leno et al. (2021) divide the process of TM into three phases: 1. collect and preprocess the UI logs; 2. identify processes for RPA; and 3. identify executable RPA routines. Phases 2 and 3 show that this procedure represents a concrete RPA use case. [14], [29] Linn et al. (2018) describe TM independently of an RPA application more detailed using the two higher-level components of "recording" and "analyzing" the data. "Recording" consists of collecting data from different desktop applications. These are evaluated ("analyzing") and a process model is identified. As a result, processes can be monitored, improved, or automated. Between these two steps, the data is consolidated. [18]

In terms of procedure, this largely coincides with the steps that solution providers, such as *Celonis* here as an example, take in five steps. [15]

1. *Collect desktop data:* Mouse clicks and any user interactions are recorded and time-stamped. In addition, screenshots are collected.
2. *Add business context:* Using Optical Character Recognition (OCR) technology, words, numbers and characters are recorded during interactions and assigned to activities.
3. *Group activities:* Next, all recorded activities are sorted using Natural Language Processing (NLP) and Artificial Intelligence and grouped into activities, such as approve purchase order.
4. *Align with business data – Analysis:* TM can link and align user interactions and business data using case IDs and understand variances and business process implications.
5. *Optimization:* Finally, processes can be optimized using the TM data.

Collecting screenshots and reading them via OCR technology is common practice, but there are alternative ways such as capturing data in a terminal emulator environment, as offered by *UltimateSuite.* [30], [31]

2.3 Application areas

In the literature review, four TM applications were identified: a) Monitoring b) Process efficiency, c) Resource enhancement, d) Identification of automatable processes. They are described in the following: [16], [32]

a) *Monitoring:* By applying TM companies can monitor their processes and tasks and check whether they are executed according to standards. Thus, deviations can be identified. Furthermore, the way of working of different users, departments, business units or subsidiaries in different countries can be compared. [16], [32]
b) *Process efficiency*: Once processes and their tasks are recorded, inefficiencies, such as process steps which cause bottlenecks, can be identified. Another opportunity is to implement best practices identified in a comparative or variance analysis during the monitoring phase. [16], [32]
c) *Resource enhancement*: This use case follows the target of identifying inefficiencies in the allocation of tasks and/or personnel. TM enables organizations to calculate average execution times or error rates of a tasks to allocate resources, especially human resources optimally. [16], [32]
d) *Identification of automatable processes*: TM reveals repetitive processes or sub-processes. UI logs can serve as a preparation for implementing RPA. RPA providers such as *UiPath* even offer TM in combination with RPA within one software solution. [27] However, other providers offer to convert the TM results directly into a platform-independent program language, which can be used by various RPA software applications. [14], [16]

2.4 Solution providers

There are many companies that offer TM often as part of an RPA or PM product. According to a study by Gartner, in 2021, revenue from PM and TM technologies grew 37 % globally. Growth is expected to continue until 2025. [33] Gartner counts 26 TM vendors in its April 2022 "Market Guide," compared with Everest Group's early August 2022 "Technology Provider Landscape" report on TM, which identifies 17 companies as “Leaders”, “Major Contenders” or “Aspirants”. Examples of "Leader" providers are *Nintex* with *Kryon Process Mining*, *Soroco* with the *Scout Platform*, *Automation Anywhere* with *FortressIQ*, *NICE* with *Automation Finder* and *EdgeVerve* with *AssistEdge*. "Major contenders", for example, are *Celonis* with the *Celonis Execution Management Platform*, *UiPath* with *UiPath Task Mining* and *Ultimate Suite* with a product of the same name. [19], [33] A comparison of the “Major Contenders” *Celonis*, *UiPath* and *UltimateSuite*, each of which has a different background (PM, RPA, TM), shows that the solution providers pursue different ways in terms of data acquisition. *Celonis*, for example, uses screenshots and OCR technology to capture data, and *UltimateSuite* uses a terminal emulator environment. [15], [27], [29], [34]–[39]

3 METHODOLOGY – CONCEPTION AND IMPLEMENTATION OF A QUALITATIVE EMPIRICAL STUDY

A qualitative empirical study applying expert interviews was designed to answer the research questions described in the introduction. The design of this study (selection of experts and development of the interview guideline) and how it was conducted as well as the analysis method are described in this section.

3.1 Selection of experts

Experts are individuals who have specialized knowledge about the subject under investigation and can thus contribute to answering the research questions. [21], [40] For this work experts from TM solution providers and consulting companies as well as experts who do not have any experience with TM but are using PM or RPA have been considered in the selection process. The involvement of the experts was predominantly done via an Internet and LinkedIn search. The panel (see Table 2) finally included four experts from leading solution providers (Sol.), one consultant (Con.) who is intensively involved in RPA as well as PM and one PM user (Use.) without TM experience. The names of the interviewees as well as their companies have been pseudonymized.

3.2 Interview conduction and guideline

At the beginning of the interview, the research purpose was explained, permission for recording the interview was obtained, and data protection (e.g., desired anonymization) was clarified. In the interview itself, the expert status was first confirmed via introductory questions and a common understanding of the used terms was

Table 2: Interviewees

No.	Alias	Position	Company	Experience
1	Con.A	Managing Partner	Company A (consulting company)	RPA, PM Consultant
2	Use.A	Specialist Purchasing Tools & Processes	Company B (automotive industry)	PM User
3	Sol.A	Solution Engineering	Company C (one of the leading PM and TM platform providers)	TM Solution Provider
4	Sol.B	Sales Director	Company D (one of the leading automation platform providers)	
5	Sol.C	Chief Sales Officer	Company E (one of the leading TM providers)	
6	Sol.D	Chief Product Officer		

created. After that, filter questions were asked to assess the relevance of individual parts of the guideline and extensive information was collected from the interviewees via the questions in the main part. [21], [41] The interview guideline structured in categories (C) according to the research questions formulated in the introduction is shown in Table 3. In addition, questions about the solution providers' products were added to the interviews. Depending on the category of the interviewee some questions were slightly modified.

All interviews were conducted online in German or English using the collaboration software Microsoft Teams due to large geographical distances. The interviews were recorded and fully transcribed.

3.3 Qualitative content analysis according to Mayring

This paper follows the particularly systematic, and rule guided qualitative content analysis method according to Mayring (2015) to analyze the transcribed interviews. The data preparation and content analysis are performed in the software application "MAXQDA", which supports content analysis according to Mayring (Categorization, paraphrasing, ...). [21], [25], [42] From the three analysis techniques explication, structuring, and summarization [25], we use the summarizing qualitative content analysis, which allows to present individual factors to the research questions in a well-structured way. For this purpose, the transcripts are first reduced step by step by structuring the text into analysis units. We applied a deductive and inductive approach to develop the categories, which is common practice in qualitative content analysis. The main categories were defined deductively based on the research questions and the sub-categories inductively based on the data material. In a further step, the narrowed down text material is paraphrased and thus brought to a consistent level of language. Finally, a second reduction of the paraphrases leads to the summary, which contains all relevant information addressed. [25], [42], [43] The results are presented in the next section.

4 RESULTS

This section presents the results according to the four research questions RQ1 [Potential Benefits], RQ2 [Opportunities], RQ3 [Risks] and RQ4 [Dissemination].

4.1 Potential benefits

Five factors were identified in the expert interviews. They are shown in Table 4 ranked according to the number of experts who referred to it.

The potential benefits a), b) and d) described by literature have also been mentioned by the experts. In addition, the experts mentioned the aspects c) and e). They are all described in the following.

a) *Process transparency:* Process transparency refers to the complete understanding of a process to improve it. If PM is already used, the understanding of the process is basically present. However, PM cannot identify *how* tasks are executed in detail. Sol.C illustrates this with an insurance company that operates internationally with 300 employees in the same department. If TM is used here, a best practice for problematic or inefficient processes can be identified and applied across countries. Furthermore, Sol.C states, that even the efficacy of software bots can be evaluated, because TM can tell the millisecond how long something took. Use.A points out that efficiency often comes not from a process variant, but from the individual process step that can be analyzed using TM. Sol.B states that with TM, the "blind spots" in processes can be uncovered with manageable effort.

b) *Automation:* Sol.B uses TM to evaluate which and how many processes can be automated. Artificial intelligence is used to calculate the percentage a process can potentially be automated and how widespread it is in the company. Since in this case the TM component is a part of an RPA platform, the identified processes can be automated directly without any media interfaces. Sol.C refers to a PDD (Process Design/Definition Document) that can be created for processes that are well suited for automation. This document can be read by RPA vendors to generate automation.

c) Training needs: Sol.A illustrates the potential of adopting TM for staff training purposes as follows [translated]: "(. . .) with user training somehow speed up the process and see that people don't press the wrong button (. . .) at such a granular level (. . .)". Use.A also addresses that users often don't know or use features, which depend a lot on training. Besides, it is conceivable that users who use a system incorrectly will see an intelligent window indicating that it would be smarter to do something different now. In this way, users can be trained

Table 3: Exemplary interview guideline [PB. . . Potential Benefit; P. . . Product]

C	Question	Sub-question	Which information is relevant?	Why is the question asked?
PB	What are the main purposes of your customers?	Can you name any other uses outside of the known ones?	TM use cases	To identify as many potential benefits
	What successes have your customers already achieved with TM?	What specific examples can/may you give?	Success stories for TM	To identify as many potential benefits and opportunities
Opportunities (Implementation)	When you think of successfully implemented TM projects, what went well during implementation?	Why did it go well?	Success factors in implementation	To identify success factors for implementation
	Where, on the other hand, were the biggest problems encountered during implementations?	Why were there problems?	Implementation challenges	In order to identify or avoid problems during implementation in advance
	When you give to a customer tips for a successful implementation, what are they?	Please prioritize these.	Tips on how implementation can be successful	In order to obtain indications on which factors to pay particular attention to
Risks	To what extent did customers express concerns to your company about TM?	Which? Please describe this in more detail. What exactly did the customer mean by this? Can these usually be completely eliminated?	Customer concerns	To identify risks / barriers
	How do you respond to critics when they raise privacy concerns with you?	To what extent does the GDPR influence TM? How is it counteracted?	Privacy concerns / solutions	To counteract risks that cannot guarantee data protection.
	How do you answer critics when they say: "TM is only for surveillance"?		What is the counterargument?	To determine what arguments can be used to invalidate this statement
	In your experience, how is employee acceptance of TM?	Do you have a recommendation on how to increase adoption?	User acceptance	Recommendation to increase acceptance in the company
P	How does your TM product differ from those of your competitors?	Why should customers buy from you?	Unique Selling Point	To differentiate solution providers
Dissemination	How well TM is accepted in the market?	Can you give a percentage from your "core business" [PM/RPA] to TM?	How many companies use TM	To identify the dissemination rate
	How are the users geographically distributed?	Are there “pioneering countries”?	Which countries are TM pioneers	To identify the geographic distribution
	In which industries TM is already used?	Why is it used specifically in these industries?	Industries that use TM	To understand the spread within the industries
	Who are the main customers for TM – Existing [PM/RPA] or new customers?	Why?	Who uses TM	To identify the (potential) customers of TM

to use systems correctly and to handle processes correctly. (Sol.A)

d) *Resource enhancement:* Sol.C points out that the goal is not to dismiss employees, but to achieve new targets set by the management board (for example, a 10 % increase in sales) with the existing employees through an increase in productivity. The data shows that it is often possible to achieve far more than is planned. (Sol.C) Sol.B also points out that if a growth of 30 % is targeted, with several hundred sales employees the personnel market does not allow for such growth and, therefore, the TM motto is "more with the same".

e) *Uncovering system landscape:* Sol.A mentioned the aspect of identifying and further harmonizing the system landscape.

Table 4: Summary of benefits

	# Experts	Factor	Brief Description
Potential benefits	●●●●●●	a) Process Transparency	Process inefficiencies can be uncovered where it is not clear what is happening in the process.
	●●●●●○	b) Automation	Processes or process steps that can be automated can be identified by means of TM.
	●●○○○○	c) Training Needs	The different approaches taken by different employees in the systems can be identified. Thus, training needs can be revealed.
	●●○○○○	d) Resource Enhancement	By improving processes, company growth can be realized with the same number of employees ("more with the same").
	●○○○○○	e) Uncovering System Landscape	After TM records process steps at the desktop level, various IT systems and programs used can be identified.

Table 5: Summary of opportunities and risks

	# Experts	Factor	Brief Description
Opportunities	●●●●●●	a) Economic Efficiency	By using TM, processes can be executed more efficiently, and resources can be used optimally, which increases profitability and ultimately enhances competitiveness.
	●●●●●○	b) Employee and Customer Satisfaction	Optimization and automation can reduce the workload of employees and shorten process cycle times, which increases employee and customer satisfaction.
Risks	●●●●●●	d) Data and Employee Protection	The issues of privacy, data protection and employee protection are addressed in relation to TM and are cited as reasons why TM is still not very widespread in Germany, for example.
	●●●●●○	c) Acceptance	Low acceptance by employees, mainly due to fear of job loss.
	●●●●○○	e) Surveillance	TM can be associated with surveillance in companies because on the one hand it monitors processes and on the other hand it can be misused for observing employees.
	●●○○○○	f) Other Concerns	Other concerns include the expense of evaluating a large amount of information, employees being afraid that their personal way of working is not sufficient, or that even TM cannot record or replace human communication.

Proprietary computer systems cause costs, which can potentially be saved. With TM, not only the individual activities are recorded, but also the IT systems used. An example of this is copying data from an Excel file into SAP. During close observation, however, the employee, for example, copies the data from a PDF beforehand. Thus, Excel is only a bridging system that is not necessary. In this example, efficiency suffers due to the duplication of work, and automation would also be easy to implement. The goal here should be to understand the system landscape and harmonize it.

4.2 Opportunities and risks

In total, we identified six opportunity or risk factors, which are presented in table two, also ranked according to the number of experts who mentioned the factors and explained in the following.

The allocation of risks is not precise. For example, a lack of employee acceptance represents a risk, but existing acceptance an opportunity indeed. Accordingly, the potentially risky factors were listed under "Risks," regardless of whether they can also serve as opportunities.

a) *Economic Efficiency:* TM helps to deploy resources more efficiently, which is an opportunity in times when recruitment is challenging. Furthermore, TM can help generate positive cash flow by making high-volume repetitive activities that slow down a process transparent, allowing companies to reduce non-value-added labor hours and thus any high-priced overtime. The realization of cash discounts in the invoicing area is also mentioned in this context. (Sol.B) According to Sol.B, the ROI of TM is low, as the following example of the incoming order process shows. PM only reveals that incoming orders are in the order intake for six days. TM can be used to determine the causes for the long waiting time. If this time can be reduced to two days by optimizing the incoming order process, there is a return on investment (ROI) that finances the automation. If automation is already in place, TM can also be used to check bots (or other systems) for efficiency.

(Sol.C) An example is the measurement of the success of a process optimization or system change. In monetary evaluation, TM can be used to measure efficiency. In this context, Sol.C mentions the migration of a purchase-to-pay process from a legacy system to SAP. First, the process is recorded with the existing software. The next recording is performed after the implementation of SAP. Here, the efficiency of the system conversion can already be evaluated. If employee training is then carried out and the process is recorded and evaluated on a recurring basis, the increase in efficiency due to training can also be evaluated in monetary terms.

b) *Employee and Customer Satisfaction:* Automation and general improvement potentials, which can be uncovered by TM, can improve both employee and customer satisfaction. Use.A, for example, addresses the chronic overload that employees express. In the TM context, Sol.A speaks of employees no longer being dependent on monotonous activities. Overtime necessitated by unused potential, which may even result in tasks having to be completed on the weekend off, can also be uncovered by TM (Sol.C). Sol.B also points out that because of TM deployment, employees can be helped to acquire additional skills to "have more fun" on the job. Employee satisfaction is also related to customer satisfaction as Sol.C refers to the example that employees who have more time respond faster to customers. Improved processes can also in turn impact customer satisfaction directly by reducing cycle times (Con.A).

c) *Acceptance:* Con.A points out that digitization does not take place in the technology, but in the minds and the acceptance of the technology, which is always far ahead of the application anyway, is crucial. This is confirmed by Sol.B. who sees the biggest problems in TM implementation in employee perception. Additionally, obtaining approvals is mentioned as a potential TM "showstopper" (Sol.A).

d) *Data and Employee Protection:* When it comes to data protection, all interviewees agree that there are concerns within companies, especially when it comes to sensitive user data. The solution providers are repeatedly confronted with the fact that TM is immediately blocked, especially in medium-sized companies. Sol.A on this [translated]: *"Any time the word 'user related data' comes up, it's actually already a red flag."* However, solution providers point to a variety of mechanisms that serve pseudonymization and data protection (e.g.: recording can be started and stopped by the employee; affected windows can be defined; specific programs or folders can be released for TM; no personal data such as name or IP address is logged; the company can decide to what extent data is anonymized; . . .).

e) Surveillance: With TM it is possible to surveil employees (Sol.C). Sol.D on this: "(. . .) a lot of companies, when they first see the idea of task mining, they have a concern with monitoring employees' activities." In this context, Sol.B also points out that a works council can block TM. However, according to Sol.C TM is not intended and should not be used for the purpose of surveillance, since monitoring alone does not offer any monetary benefit. Sol.D generally puts this risk into perspective from a consultant's point of view: "But in fact, we never have an issue (. . .) when we explain how the data is collected, (. . .) processed."

f) *Other Concerns:* This paragraph summarizes aspects which were expressed only once in the interviews for the sake of completeness. First, TM software cannot record interpersonal communication. Most importantly, it does not replace face-to-face communication to get to the bottom of certain things (for example to find out that a printed mail is attached to the manager's signature folder). (Con.A) In addition, there are many processes that are performed by too few employees, which requires conventional interviews in the collection of information. Furthermore, concerns have been raised that it will cause difficulties for employees if they are shown to have done their job in a disorganized or cumbersome manner. Finally, there is a possibility that employees will act differently when recorded because they are afraid of change and may have doubts about their personal way of working. (Use.A)

4.3 Dissemination and basic requirements

In terms of *geographical distribution* all experts agree that TM is most frequently used in countries with lower employee protection and less stringent data protection regulations; Eastern Europe and the Asian region were cited as examples. Furthermore, companies whose headquarters is in German-speaking countries often use their branch offices or outsourced service centers in the above-mentioned regions to test TM. However, the use of TM in Central Europe is increasing. More and more high-wage countries such as Denmark or Germany are adopting the technology. Regarding specific industries, where TM is spread, the experts mentioned the banking, insurance, and finance sectors several times, since complex system landscapes are prevalent here and several repetitive activities are performed. Apart from this, the healthcare industry was also mentioned, as well as the fact that TM is often used in the B2C sector, as this is where particularly highly frequented processes take place. Examples include customer support and the back office, where repetitive, manual, and rule-based processes are frequently performed. Finally, the experts also referred to some basic requirements for the adoption of TM technology. The more people involved in the same process, the more appropriate the use of TM. If, for example, only 5 persons are employed, TM is not beneficial – in this case, internal interviews or workshops prove to be more economical. In contrast, a process that is carried out by 100 employees across countries is very well suited. An exemplary appropriate sub-process for TM is "Create Purchase Order", since here a lot of information, such as opening an e-mail, reading, and copying data from a PDF, pasting the data into Excel, etc., cannot be retrieved in the ERP system. Another example is the application in a call center, where the duration of data entry is checked. If many employees need more time on one screen, the possibility of improving the user interface should be examined. This results in basic requirements for TM technology adoption such as *case frequency*, *number of employees involved*, *cross-application screen work* and *legal frameworks.*

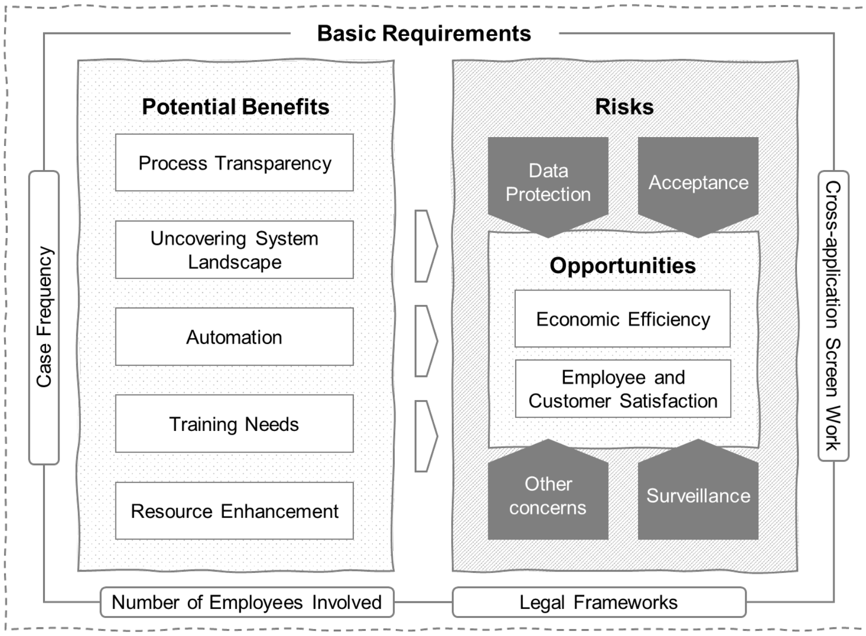

Figure 2: Framework for TM adoption

4.4 Framework for Task Mining technology adoption

In this section, the categories from the expert interviews, which were described in sections 4.1 to 4.3, are merged in a fundamental framework for TM adoption (Figure 2).

The model shows the five potential main benefit factors through which the two main opportunities of economic efficiency as well as employee and customer satisfaction can be realized. The interviews have already suggested some implications and interdependencies among the respective factors. For instance, *Automation* potentially influencing both *Economic Efficiency* and *Employee and Customer Satisfaction*. In TM deployment, however, the 4 main risk factors, where potential interrelationships were also indicated, should be considered. Other concerns, as described above, can also be inhibiting factors. Finally, regarding the basic requirements from an economic point of view, TM technology tends to be suitable for large numbers of cases, many employees involved, and when there is cross-application screen work. At the same time, legal aspects such as the monitoring of employees must be considered.

5 CONCLUSION

In this work, a fundamental framework for TM technology application was empirically developed based on qualitative expert interviews. From a scientific point of view, this framework offers some starting points for future research agenda regarding TM. Firstly, our type of expert interviews does not provide enough empirical material to prove the indicated interrelationships between the identified factors or a hypothesis about their influence. Therefore, future research could focus on empirical studies with involvement of a sufficient number of participants to guarantee statistical significance of achieved results. Secondly, the individual factors of the model could be analyzed in detail and the effect on the performance of a company provides further research needs. Third, the model is a fundamental model and first attempt to describe TM in a scientific framework. All the factors considered were mentioned in the interviews, but the model does not claim to be complete. Future research could consider experts from further TM providers, consulting firms and also companies that already use TM, and identify further factors relating to TM through interviews based on our guideline. Finally, case study-based research that examines the potential benefits in practice could provide information about success factors and barriers in implementation and realization.

In conclusion, TM technology offers several potential benefits, two of which discovered in this work – *Training Needs* and *Uncovering System Landscape* – have not been described in the literature to date. The model thus also provides a starting point for interested companies that meet the basic requirements outlined to evaluate TM deployment. This qualitatively empirically developed basic framework makes a further contribution to the still scarce scientific discourse in theory, is intended to encourage companies to engage with the technology, and ultimately to contribute to the dissemination of TM so that the VDU work of future generations is freed from monotonous, time consuming and repetitive activities. It has to be noted that societal challenges posed by increasing digitization and automation in the labor market should also be met with innovative concepts in politics and society and not misused as a justification for rejecting new technologies and maintaining the status quo.

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