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A Comparison of the Effects of a Digital Adoption Platform on Product Lifecycle Management Software

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Abstract

Product Lifecycle Management (PLM) emerged from the growing need for companies to oversee their products throughout their entire lifecycle—from design and production to usage, and even disposal. This responsibility includes managing product data, regardless of whether the product remains within the company, is in use by customers, or has reached the end of its life in a landfill. PLM systems aim to centralize and allow editing of all product-related data across departments and stages. However, integrating such comprehensive tools into industrial environments is often challenging. The diversity of professional roles each with distinct cultures, expertise, and technical languages complicates seamless adoption and efficient use of PLM systems. To address this challenge, Digital Adoption Platforms (DAPs) have emerged as complementary tools. DAPs are software layers that integrate with existing applications to guide users through processes via step-by-step tutorials, contextual tooltips, and input suggestions. While DAPs have proven effective in many enterprise software domains by easing onboarding and increasing productivity, their use within PLM systems remains limited and under-researched. Particularly, there is a lack of data on how DAPs affect the usability of complex PLM systems and whether they offer tangible improvements for novice users. This study aims to evaluate the usability of PLM systems enhanced by DAPs. By analyzing the user experience and measuring performance, the research seeks to determine whether DAP assistance leads to better adoption, reduced training time, and improved user satisfaction. The findings will also help identify the underlying reasons behind any observed benefits or limitations.

Keywords: Digital Adoption Platform, Product Lifecycle Management, Usability.

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1 Introduction

1.1 Context

In today's industrial environment, companies are under increasing pressure to improve the efficiency and quality of their product development processes. Product lifecycle management (PLM) software has become essential for managing, in an integrated way, all the information and processes associated with each stage of a product's lifecycle, from conception to withdrawal from the market. These IT systems streamline workflows, improve interdisciplinary collaboration and reduce time-to-market. However, due to their inherent complexity and the multi-cultural inclusion of end-users, whether business, linguistic or social, the adoption of these tools by end-users can prove difficult, which can compromise their effectiveness and return on investment.

What's more, these tools are constantly evolving to suit as many businesses as possible. This multiplication of sectors targeted by PLM tools means an increase in the functionalities available in a single tool. Careful parameterisation is therefore required to ensure that users are not overwhelmed by too many functions that are unnecessary or unsuited to their business practices. This parameterisation is therefore critical, and it has become common practice to call on experts in these tools to deploy them.

Digital Adoption Platforms (DAPs) have emerged as an innovative solution to these adoption challenges. DAPs offer interactive guides, real-time tutorials and contextual support directly integrated into users' workflows, making it easier for them to learn and master complex software such as PLM systems. By providing contextualised learning support, helping to identify errors and reducing the learning curve, DAPs can potentially improve the user experience and, consequently, the overall effectiveness of PLM systems.

1.2 Problem

Despite the potential of DAPs to facilitate the adoption of complex software (Handrich & Otterbach, 2024; Hilbert et al., 2022), no study has measured the usability of a PLM tool supported by a DAP. Because PLM tools must support every business function involved in a product's lifecycle, they must accommodate widely differing user expectations, workflows, and levels of expertise. This diversity makes them especially challenging to use consistently across roles. And this is precisely where DAP can have an impact, as it helps to avoid user errancy. Usability is a key determinant of software success in industrial environments, and encompasses aspects such as ease of use, efficiency, and user satisfaction (Sivakumar et al., 2024) The central research question of this study is therefore: is there a significant increase in usability between PLM software supported by a digital adoption platform, and why? This question is key to understanding whether the addition of a DAP can truly improve the user experience and maximise the benefits of PLM systems, without any drawbacks.

1.3 Research Questions and Hypotheses

The general research question that motivated the experiment can be broken down into more specific research questions.

RQ1. Is the usability of a PLM tool enhanced by the use of a DAP?

RQ2. Which elements contributed by the DAP are those most involved in this gain?

RQ3. What are the trade-offs in using this technology on a PLM tool?

According to the Everest and Gartner reports cited above (Handrich & Otterbach, 2024; Hilbert et al., 2022), it is suggested that DAPs help accelerate software adoption, without going into further detail. In other contexts, it has been shown that systems that respond to user demand by interacting with users just when they need it, and in the most appropriate way possible, enable smoother use (Mavropoulos et al., 2021; Rook et al., 2020). However, it is reasonable to assume that this will be achieved by facilitating task completion, which may result in an improvement in the triptych of completion quality, user cost and task completion time. We therefore put forward the following hypotheses in response to the first question, which will need to be validated experimentally:

H1. Individuals using PLM with DAP are less prone to errors than those using PLM without DAP, act faster and perceive a gain in usability.

H2. People who use PLM with DAP complete their tasks faster than those who use PLM without DAP.

H3. People who use PLM with DAP find their PLM tool more usable than those who use PLM without DAP.

Next, it will be necessary to identify what contributes to the validation of these hypotheses, and what the counterparts will be.

1.4 Statements of Contributions

This study aims to contribute to the literature by using a controlled experiment to examine the impact of a digital adoption platform on the usability of PLM software. By comparing the experiences of users working with PLM alone and those using PLM with the assistance of a DAP, as a contribution to practice, this research will provide insights into the effectiveness of DAPs as usability enhancement tools. The results of this study can guide companies in making evidence-based decisions regarding DAP deployment to improve PLM system onboarding, user efficiency, and satisfaction. Finally, results pave the way to recommendations for designing and evaluating DAP software and content used to guide users. In addition, this study could integrate the type of software that DAP is and the metrics associated with its use into academic knowledge.

1.5 Limits

Several threats to validity need to be taken into account. Firstly, participants were novices in PLM but the variability of participants' PLM and project management skills may affect the results, as experienced users may benefit differently from DAP assistance than novices. Secondly, the experiment focuses on five tasks relating to configuration management, documentation management, project planning, approval management and part revision. These may limit the generalisability of the results to other functions of a PLM software (e.g., …). Finally, the effectiveness of DAP is highly dependent on the quality of the walkthroughs, which varies according to the working environments, the number of authors used to create the walkthroughs, and the configurations of the systems used.

Despite these limitations, the study offers a first assessment of how DAPs improve usability in complex PLM environments and opens avenues for future research on their adaptation across contexts.

1.6 Outline

The remainder of this paper is structured as follows: in the next section, we detail the methodology used to conduct this study, including user experience design and usability evaluation criteria. Next, we present the results obtained, followed by an in-depth discussion of their significance and practical implications. Finally, we conclude with the limitations of the study and suggestions for future research.

2 Related works

2.1 Product Lifecycle Management

Product Lifecycle Management (PLM) is “a strategic product-centric, lifecycle-oriented and information-driven business approach that strives to integrate people and their inherent practices, processes, and technologies, both within and across functional areas of the extended enterprise from inception to disposal” (Pinquié et al., 2015) that aims to structure and coordinate all the information and processes required to design, manufacture, distribute and dispose to a product throughout its lifecycle (Stark, 2022). This approach is strategic for companies, as it enables integrated and continuous management of product data, from the earliest design phases through to the product's withdrawal from the market.

PLM is based on the idea that a product goes through different phases during its life, each involving critical information and decisions. These phases include design, prototyping, manufacturing, deployment, maintenance and, finally, end-of-life (Fortin et al., 2020). Using an approach that includes PLM, companies aim to optimise each stage, ensuring that the data and knowledge acquired during the previous phases are capitalised on to provide digital continuity (Carvalho et al., 2025). This continuity makes it possible to improve the quality and responsiveness of operations and reduce costs and lead times by minimising the risks of duplication and communication errors between teams (Singh et al., 2020).

PLM also implies interdisciplinary collaboration. Given that each phase of the lifecycle involves teams with different areas of expertise (design, production, marketing, maintenance, quality, etc.), PLM encourages a holistic, cross-disciplinary approach as exposed in Fig 1 (Rivest et al., 2019; Demoly et al., 2013; Kakehi et al., 2009; Lee et al., 2008; Maranzana et al., 2020; Pinna et al., 2018; Prashanth & Venkataram, 2017; Singh et al., 2020; Vila et al., 2017). As a result, teams can work with a shared vision of the product's objectives, which improves strategic alignment and the coherence of actions (Siller et al., 2008).

In addition, PLM includes a strong compliance and traceability management, which is necessary in today's industrial production. It therefore includes role, version and configuration management to meet this need (Ziani et al., 2022).

2.2 PLM tools

In this study, the term “Product Lifecycle Management” refers to a set of practices aimed at managing product data throughout the product lifecycle, while the term “Product Lifecycle Management tool” refers to the software that supports PLM practices (Stark, 2024). The reason for this differentiation is that, in our case, we are interested in the digital adoption of a digital tool, not a concept. More so as this concept does not intrinsically presuppose the use of a tool alone (Maranzana et al., 2020), nor of a solely digital tool. The main principles set out by John Stark (Stark, 2022) could be applied with paper tools on a systemic scale small enough not to be limiting.

However, in our case, we are interested in the adoption of digital tools. Thus, this study concerns a practical case of the use of PLM software, 3D EXPERIENCE from Dassault Systèmes (Petro, 2025) and Teamcenter from Siemens (Guyon et al., 2024). The experiment involves performing tasks that can be applied to a large number of other software applications designed to respond to and apply PLM principles, including:

- Fusion from Autodesk
- Windchill and Arena from PTC
- Aras PLM from Aras

The diversity of software interfaces, often inherited from the business practices of specific industrial sectors, makes adoption difficult. Each tool is expected to match users, who can range from methods engineers to CAD draughtsmen, to enable the application of PLM. However, cultural differences, whether due to business practices, industry sector or corporate culture, make it difficult to adapt the UI Design of PLM tools to all these users. Finally, the diversity of business processes between companies means that business practices have to be relearned when an employee changes company.

Business processes form the basis of the actions carried out by each stakeholder in a PLM system. The definition of these processes is used to parameterise the PLM system and assign roles. These processes have different levels depending on their application. The first process levels are used to define inter-business unit or inter-company interactions within extended enterprise frameworks. Low-level sub-processes are required to identify and allocate tasks within the PLM system between users.

The lowest-level processes involve a maximum of ten or so stakeholders, according to our observations in 4 French companies of international standing. In order to be represented and communicated using standard digital tools, they are broken down into a maximum of twenty or so stages.

PLM tools are adapted to apply all or part of these processes, which until now have been defined regardless of the PLM tool used. Each PLM tool remains relatively configurable in order to respond to these processes, within the limits of the industrial culture it has often defined: 3DExperience as the heir to Dassault Systèmes products, Teamcenter developed in the Siemens environment, etc.

According to (Yüksel & Çakmak, 2024), 31.1% of PLM system users have encountered difficulties when using a PLM system. Similarly, 42.9% of respondents found problems in the strategy followed for process integration, and only 39% found the PLM system easy to use. This paper identifies a way forward that involves better monitoring of users' specific expectations.

This suggests that it would be appropriate to experiment with the use of a digital adoption platform on these PLM tools.

2.3 Digital Adoption Platform

Before deploying a digital adoption platform, it is necessary to define what this type of software is.

The digital adoption platform provides support to each software user by means of publications on the software interface. These publications can be static stickers, like road signs, to display information on the interface systematically or under certain conditions, or active walkthroughs to display a sequence of publications (see Figure 1).

Several players are currently developing solutions, including: WalkMe, Pendo, WhatFix, Knowmore.

The main functionality that is most analogous to the process found in PLM is walkthroughs. In fact, a low-level process characterises a sequence of tasks to be carried out, like an operating procedure, whereas a walkthrough shows where to click in a software interface. The user selects the walkthrough according to what they want to do, then the DAP launches the walkthrough so that, step by step, the user can see what they have to do directly on the software interface.

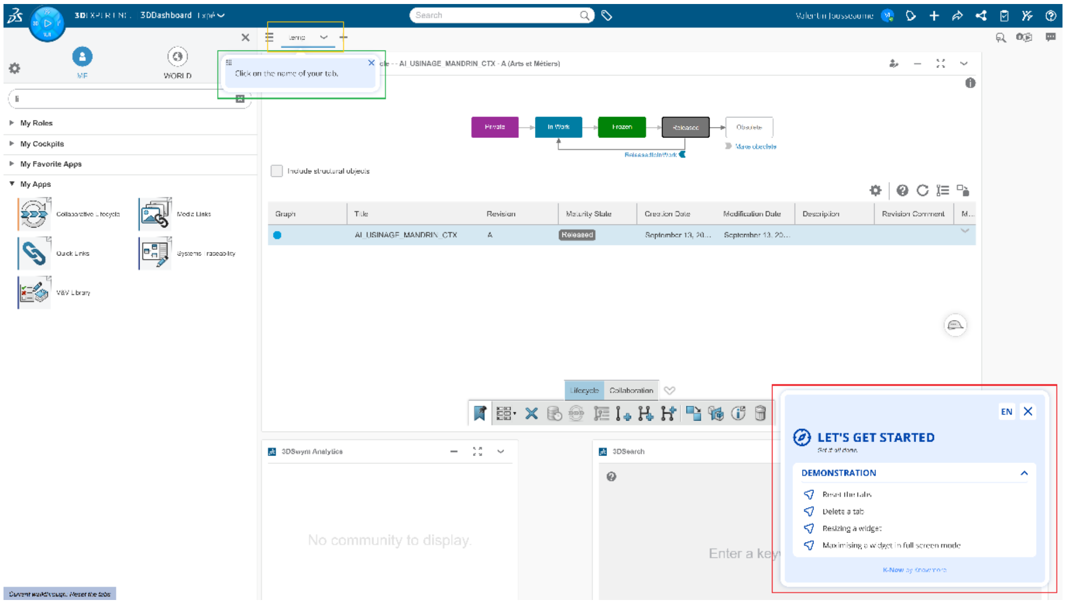


Figure 1: Example of guidance on 3dexperience, with the compass menu in red, a step showing a message in green and an anchoring element from the interface in yellow

However, this involves defining what the user needs to do in advance. The people responsible for carrying out these tasks are commonly called authors. They produce the appropriate walkthroughs so that as many low-level processes as possible in a PLM framework can be assisted by the DAP at the user's request.

Depending on the DAP, the walkthroughs are displayed just above the interface without any precise positioning or point directly to an element of the interface. In parallel, some detect the presence of elements or clicks by the user to move on to the next or appropriate step.

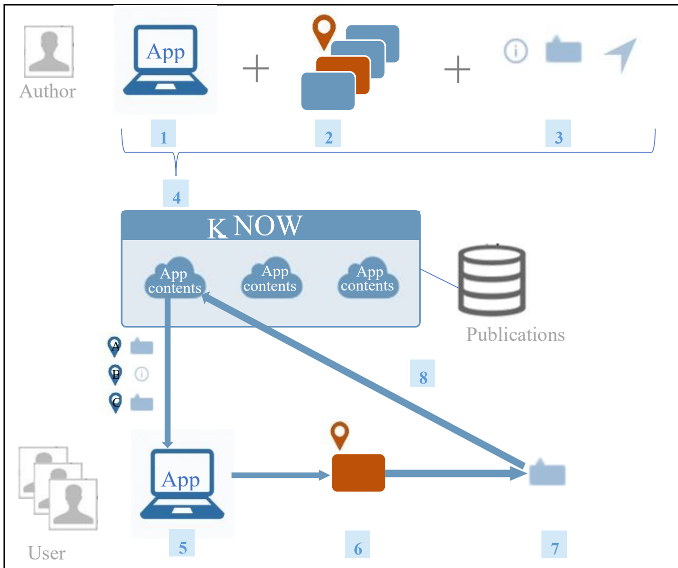
In this study, the interface elements will be referred to as ‘anchoring elements’. They constitute one of the main technical difficulties for DAPs (Sweary et al., 2023), since interface elements change between different software packages. In addition, walkthroughs vary from one software to another, since the sequence of clicks varies from one software to another, despite being based on common processes.

For example, with Knowmore's K-NOW DAP, an experienced author creates and receive around twenty walkthroughs a day, each consisting of around ten steps. The order of magnitude of the number of walkthroughs required for a PLM project is around one hundred for initial deployment. Similarly, the number of end users is in the region of a thousand. In terms of use, 10,000 users launch 100 walkthroughs per day and complete them in around ten minutes, depending on the process followed.

The second functionality consists of providing feedback and collecting analytical data. Because of the nature of a DAP, it is possible to collect information about the end use of the tool to which it is grafted. There are two ways of collecting data: explicitly and implicitly. The first method involves using surveys and Likert scales to measure. The second is to use server logs for each publication.

The third feature is the display of pop-ups. This makes it possible to quickly inform end users, directly via the application they are using, of changes in their commercial practices.

The final functionality corresponds to the task automation and knowledge management sub-tools. These include autocompletion, input assistance, user path management and so on. These tools are not visible to end users. (Handrich & Otterbach, 2024). The architecture of K-NOW, the DAP used in this study, is as follows:



DAP application Diagram

1. The author goes to his application, where he wants to add content
2. K-NOW locates the location for him
3. The author chooses a format (sticker, suggestion, guide, …) and writes the content
4. The author saves these publications on the DAP server, and puts them online
5. K-NOW asks the IDP, the user's identity as well as profile data through an web extension
6. User workstations solicit K-NOW through a tag in the application or a browser extension. The list of locations and messages is passed to the browser
7. K-NOW recognizes the location where it should display content
8. Statistical content usage data goes back to the server (display, reading, click, etc.)

Figure 2: K-NOW technical architecture diagram

In our study, all the experiments were carried out with K-NOW from Knowmore and 3DEXPERIENCE for 10 participants and Teamcenter for other 10. It includes all the above functionalities. In the next section, we will look in more detail at what this study focuses on among all these features.

This entire study was conducted using experience gained from five real-world PLM deployment projects. On average, a PLM deployment project supported by a DAP represents 4% of the total cost of the PLM deployment project alone. Each DAP deployment is carried out by a DAP project manager assisted by a connector developer who communicates with the PLM deployment stakeholders in order to install the DAP on the interface following the architecture shown in Figure 2.

2.4 Usability

Usability is becoming increasingly important in the design of digital systems and applications. According to ISO 9241-11, usability is defined as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Dietlein & Bock, 2019; Escobedo et al., 2024). Since PLM tools are to be used by a large number of different users, it is desirable to carry out this measurement for all tools used in a PLM and industrial context.

One problem with usability is its measurement(Hornbæk, 2006; Khajouei et al., 2018). In the ISO definition, effectiveness and efficiency can be observed through a comparison with an expected result, for example, or measured with quantities such as time, but satisfaction, which is an integral part of usability, is only taken from the perception of users. This gives us two types: perceived usability and actual usability (Nielsen, 1994; Salminen et al., 2022).

Depending on the two types of usability, the quality of the measurement will therefore vary. If we measure actual usability without taking user satisfaction into account, we can use simple quantities such as execution time, the number of tasks correctly carried out, the number of products of these tasks that comply with requirements, etc. If we want to measure perceived usability, we prefer to use psychological tests such as the System Usability Scale (SUS).

Usability has the advantage of being measured by a number of methods with a number of scales, such as the SUS, which enable direct comparison with other systems. What's more, since our objective is to compare values, some of which are subjective, usability allows us to use measurement methods that have already demonstrated their experimental validity, with recommendations for use and known limits.

Finally, insofar as we were only able to experiment on a limited number of participants from a population that does not represent the full range of cultural, professional and mental variations, this makes it possible to provide a decently rigorous framework for observation.

2.5 Synthesis

The literature review shows that DAP has only recently appeared in scientific publications a few times. It includes two things. First, using DAP on a PLM software is original, relative to the publications (Sanjiv & Srinivasa, 2020). Secondly, using network graphs to monitor DAP deployment seems never to have been carried out, too, but graphs are more and more usual to monitor big data, and guidance for a DAP represents a lot of elements.

From this review, we can see that our problem is an original one, in the way that existing solutions that have been developed according to an initial need and context are no longer sufficient in our case study. Furthermore, the elements that make up our solution are inspired by solutions to very similar problems, but which nevertheless remain outside their native application context. We are faced with a number of technological barriers, specific to the implementation of DAP on a PLM tool: production cannot be received globally, and it is not possible to check the consistency of production with what has been planned. These barriers will be overcome in the proposed paper. We also have a scientific barrier: we know of no DAP deployment method specific to a PLM tool. This lock will be partially lifted by exposing the method of using graphs for the receiving part but will be developed through other work.

3 Method

3.1 Research Questions and Hypotheses

As a reminder, the objective is to study whether there is an increase in the usability of PLM tools, and above all to find explanations and nuances, according to the following issues:

RQ1. Is the usability of a PLM tool enhanced by the use of a DAP?

RQ2. Which elements contributed by the DAP are those most involved in this gain?

RQ3. What are the trade-offs in using this technology on a PLM tool?

The hypotheses associated with RQ1 are as follows:

H1. Individuals using PLM with DAP are less prone to errors than those using PLM without DAP, act faster and perceive a gain in usability.

H2. People who use PLM with DAP complete their tasks faster than those who use PLM without DAP.

H3. People who use PLM with DAP find their PLM tool more usable than those who use PLM without DAP.

Next, it will be necessary to identify what contributes to the validation of these hypotheses, and what the counterparts will be to answer RQ2 and RQ3.

3.2 Experiment Design and Protocol

In this experiment, a between-groups design was chosen, pitting two distinct groups of participants against each other to compare identical tasks and limit the learning effect. The experimental group uses a PLM (Product Lifecycle Management) system with an integrated DAP (Digital Adoption Platform), while the control group only uses the PLM without the DAP. This design makes it possible to compare the effects of the DAP on PLM users.

The experiment therefore took place on a Windows 11 laptop, with the Chrome browser to display the PLM tool, either Teamcenter for 10 participants, or 3DEXPERIENCE (Makhkamova et al., 2025). The objective with the use of two different tools is to mean the results and try to exclude specificities. The tasks were virtually identical, the only variations being the names of the applications used in the tool. The guides were designed to share as many clicks as possible between the two tools. Participants had 2 screens, which they could arrange as they wished, a mouse and an additional keyboard if they so wished.

The experiment consists of carrying out 5 tasks on 3DEXPERIENCE or Teamcenter as an activity simulation (MacKenzie, 2024). The time is timed and the screens recorded. Participants assumed the role of a design project manager and performed tasks based on simulated requests from a chief design officer. This is why the tasks are formulated in the form of a list contained in an e-mail from the said superior. This formulation corresponds to the traditional formulation of an email request in Western culture (Skovholt & Svennevig, 2006; Wasiak et al., 2010).

The tasks are as follows for 3DEXPERIENCE:

1) Approve a modification to a part using Collaborative Lifecycle. The part to be validated is “Plate 2.1”, which has been put into Frozen. After an inspection, it must be validated or not by switching it to Released.
2) Adding a document to a project with Project Planning. The contract.txt file must be added to the contents of the "Experience" project.
3) Create a part variant using Collaborative Lifecycle. The part for which you need to create a variant is “Plate 2”. A new variant 2.x needs to be created.
4) Create a schedule using Project Planning. You need to plan to carry out a part review phase with X and a validation phase following this in the Experience project.
5) Create an approval request with Collaborative Tasks. You need to create a request for approval to be carried out by X with a new task and then add the “Plate 2.1” part as the relevant deliverable.

The tasks are as follows for Teamcenter:

1) Approve a modification to a part in the project file. The part to be approved is Plate 1 in the "Knowmore" folder. After an inspection, you may or may not validate it using Released workflows.
2) Add a document to a folder. Put the file "Contract.docx" in the "Knowmore" folder.
3) Create a new variant of Plate 2 in the same folder.
4) Create a schedule with Schedule. Plan to carry out a half-day part review phase, followed by a validation phase.
5) Create a workflow request for approval of Plate 2 in Inbox. No one will be affected especially.

The participant is told that, like a real project manager, he has access to all the tools he knows that could be useful to him in carrying out his task (web search, tutorials, software help documents, etc.). In operational conditions, a project manager is entitled to outside help, as long as it is available, when carrying out his tasks. The only assistance prohibited is the intervention of the examiner. The aim is to measure the usability of the tool under the most realistic conditions possible, using a standardised data set.

Tasks are to be completed to the best of our ability. If any information seems to be missing or erroneous, the participant can choose to find a compromise or not to finish the task, while mentioning the reason for its non-completion to his/her experimenter. Task completion is interrupted if it exceeds one hour. This was not the case. Once the task has been completed, the participant is asked to complete a System Usability Scale questionnaire.

A phase of 4 days plus or minus 1 is left in order to go over the errors or difficulties with the participant through a semi-structured interview. The participant is then free to raise subjects or ask questions relating to his or her experiment. The aim is to collect the highlights of the participant's experience (MacKenzie, 2024). First, the examiner recalls the title of the task and asks the participant to describe what he did. If the participant does not remember everything, the examiner repeats it orally without showing the missing points. The examiner explains the mistakes made and asks the participant to justify them. Finally, the participant is given a new System Usability Scale to see how the result has changed. The interview should take 30 minutes plus or minus 15.

3.3 Variables

Here, the independent variables present in the experiment are the presence or absence of a DAP between the test group and the control group. The PLM tool tested can be considered as a secondary independent variable, even if the objective throughout the study is to have a general PLM tool, and not conclusions specific to one tool in particular.

The control variables are the number and type of tasks requested, even if their click-through rates differ. The completion time is identical, with a maximum of one hour. The instructions are formulated in the same context and the working environment is identical, as shown in Figure 3. Finally, the evaluation procedure is similar regardless of the tool or the group.

For the random variables, the experience of the participants with the tools used varies, after the knowledge test, from beginners who have hardly touched the tool to users who have already handled it for projects. The level of ergonomic comfort also fluctuates, as will be mentioned in the observations, depending on the computer usage habits. Problem-solving skills also varied greatly, the objective being to have a representative panel of users in a real-life application of what was observed in deployment projects.

The dependent variables are task execution time, success rate, SUS score and recall ability. The dependency links will be explained later in the results section (Figure 3).

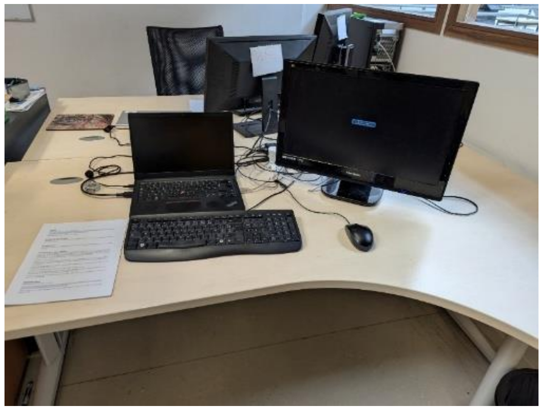


Figure 3: Setup

3.4 Setup and PLM Tool Tested

To conduct the experiment, we selected two representative and widely adopted PLM systems used in industry: 3DEXPERIENCE (Dassault Systèmes) and Teamcenter (Siemens). 3DEXPERIENCE integrates design, simulation, and lifecycle management within a unified collaborative platform, enabling end-to-end product data continuity and digital twin capabilities (Ganesan et al., 2025). Teamcenter offers scalable PLM functionalities with strong integration across CAD, ERP, and manufacturing systems to support global product development. These tools were chosen for their completeness and representativeness of current industrial PLM solutions, ensuring realistic and generalizable experimental conditions.

3.5 Participants

The experiment was carried out with 20 participants: 10 in a PLM-only group and 10 in a PLM group assisted by the DAP. The participants were engineering students (14 of them), working engineers or industrial project managers (3 of them) and doctoral students in industrial engineering (3 of them). The average age of the participants is 31.6 (22 to 44, s.d. of 5.1), and they are all French except for one Chinese. They were randomly allocated to the different groups and a sample of their level in digital adoption and PLM was taken during the first part of the experiment to verify the equilibration of the groups.

All the participants had sufficient knowledge of industrialisation to carry out the tasks requested through the experiment, even if only 50% of them felt confident in carrying out the tasks through 3DEXPERIENCE or Teamcenter. Finally, 60% of participants knew what a digital adoption platform was.

3.6 Usability Measurement

As mentioned above, we need to measure perceived usability and actual usability. We use the System Usability Scale to measure perceived usability, just after the test, and secondly just after feedback from the memorisation and learning test (McLellan et al., 2012). This test has the advantage of being generic to a large number of system types and is well-known in the scientific literature.

To evaluate the actual usability, we measure the completion time and error rate, common KPI used in industry (Alonso-Virgós et al., 2020).

Finally, we carry out a memory test 4 days later to assess the learning provided by the DAP (Bradley, 2021; Tulving & Thomson, 1973). The test is carried out 4 days later, plus or minus 1, as this fits into a week from a practical point of view and allows us to test the early consolidated memory of the tasks. These tests are sequential remembering tests with more and more descriptive clues to evaluate the accuracy of memory. To do that, we ask each participant face-ot-face to remember the task, which we name by its number. If that's not enough, he's given a verbal reminder of the task. If that's not enough, we give him the written task, which he can consult as many times as he likes. If that's not enough, the examiner describes the task in two sentences. If that's not enough, he's given a picture of what he was doing on the tool. Finally, if that's not enough, he's given access to the video of what he did.

4 Results

4.1 Validation

To validate the hypothesis, we need to study the results of the SUS score in order to detect a statistically significant difference. We have two different samples of 5 participants, whose profiles have been checked to ensure group balance with perceived skills tests and real skills tests. Our results are as follows in Figure 4.

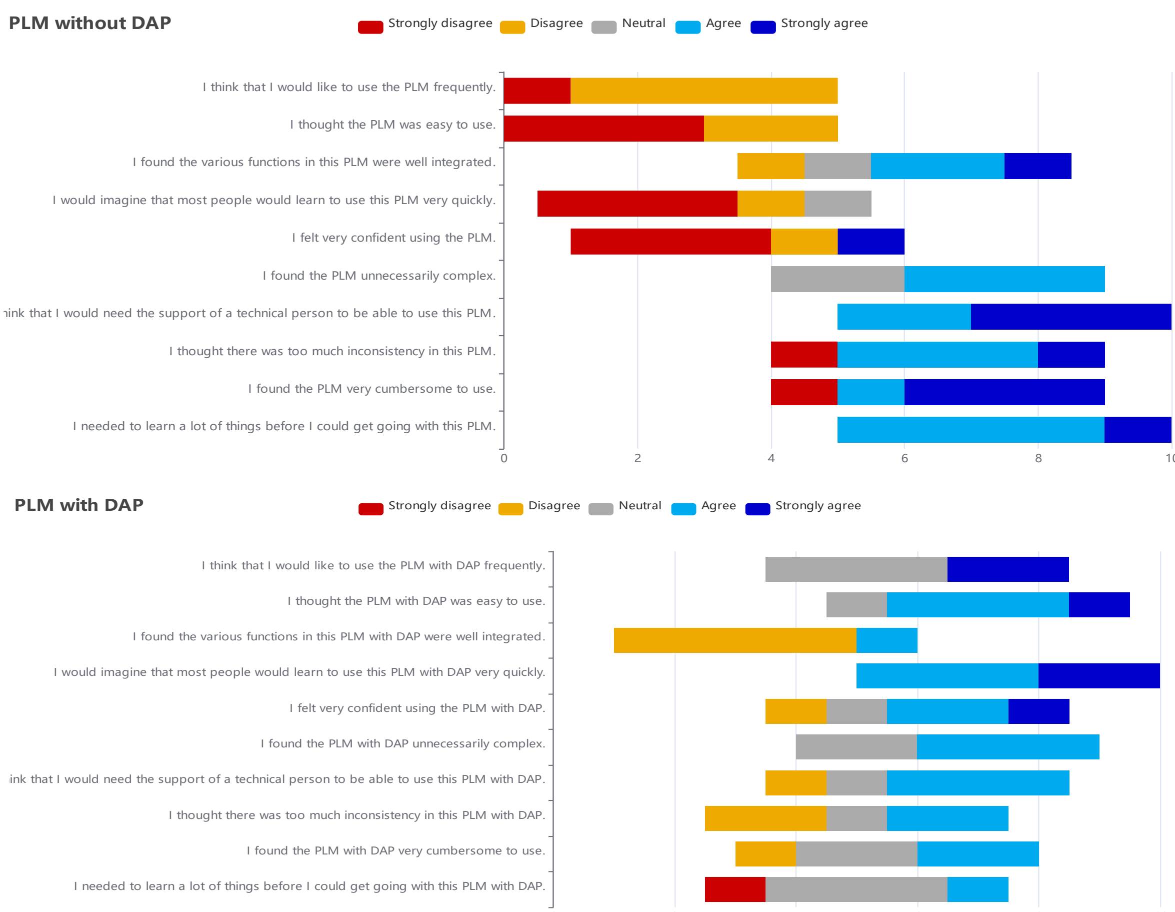


Figure 4: SUS score

The two samples are independent because the participants are two different populations and do not communicate with each other... We want to know whether or not there is a significant difference in the results. We'll test the samples to see if they reasonably follow a normal distribution, and then use a Student's t-test to test the hypothesis: “The SUS values of the control population are identical to those of the test population”. Similarly, we will test analogous hypotheses with task completion time and the number of tasks correctly completed. For time measurement, it is also necessary to filter the data. We'll then look at the time value whatever the task outcome, but also only for correctly completed tasks.

To check that the distribution follows a normal distribution, we use a Kolmogorov-Smironov test. We obtained p-values for the SUS distribution of 0.374 for the test group and 0.496 for the control group. For the times, we also test the log times, since they are more suitable for postulating a normal distribution, as they are no longer strictly positive. For tasks 1,2,3,4 and 5, and for test and control pairs respectively, we obtain: (0.510, 0.582), (0.856, 0.109), (0.858, 0.313), (0.646, 0.446), (0.843, 0.768). Finally, to measure whether the tasks have been carried out correctly, we perform the same test on the number of tasks carried out, with the functionality of the final result as the measuring tool. A task is considered valid if the product of that task can subsequently be used by another user. We then obtain the following p-values, always in the same order: (0.153, 0.304).

With all these p-values, we cannot refute H0 and must postulate that these values do not differ significantly from a normal distribution.

Since we have tested the distribution of the samples. We can then apply a Student's t test to test the following hypothesis H0: The two samples are not significantly different. H1 is: The two samples are significantly different. We then obtain the following p-values.

First, for the SUS scores, we obtain a significant difference, invalidating H0 with a p-value of 3.4e-7. For task completion, we obtain a significant difference with a p-value of 0.00016.

For completion times, we break them down into different statistics. Indeed, it's not necessarily relevant to compare successful tasks with failed ones. However, in order to derive statistics, it is necessary to have sufficient values. What's more, the values will be in log(t). In Table 1, we show the mean of log(t) and p-values.

Table 1: Comparison of mean log(t) values between test and control groups across multiple tasks

Task n°1			
	Mean log(t) log(t) test group	Mean log(t) control group	p-value
Both PLM tools, correct tasks	0.57	0.74	0.081
Task n°2			
	Mean log(t) test group	Mean log(t) control group	p-value
Both PLM tools, correct tasks	0.48	0.58	0.429
Task n°3			
	Mean log(t) test group	Mean log(t) control group	p-value
Both PLM tools, correct tasks	0.44	0.72	0.085
Task n°4			
	Mean log(t) test group	Mean log(t) control group	p-value
Both PLM tools, correct tasks	0.38	0.56	0.056
Task n°5			
	Mean log(t) test group	Mean log(t) control group	p-value
Both PLM tools, correct tasks	0.22	0.59	0.062

In terms of execution time, none of the times in the control group exceeded those in the test group. And only the execution times for the second task showed no statistically significant improvement.

The conclusions drawn from the different measurement methods are therefore consistent: we have a significant increase in perceived and observed usability with the use of a DAP on a PLM tool. However, confrontations between the participants and a complete and detailed verification will enable us to see the limits and understand the reasons for this in the following section.

4.2 Detailed Analysis

All the tasks carried out by the participants were recorded. In order to translate their actions into this paper, we produced 5 chronograms. The aim is to analyse behaviours and correlate them with studies on patterns that can be found in this type of graph. We consider task completion even if the final product obtained at the end of the process does not conform, in order to maximize the observation of processes through this representation.

We obtain the following chronograms among 10 for the two PLM tools tested on Figure 5.

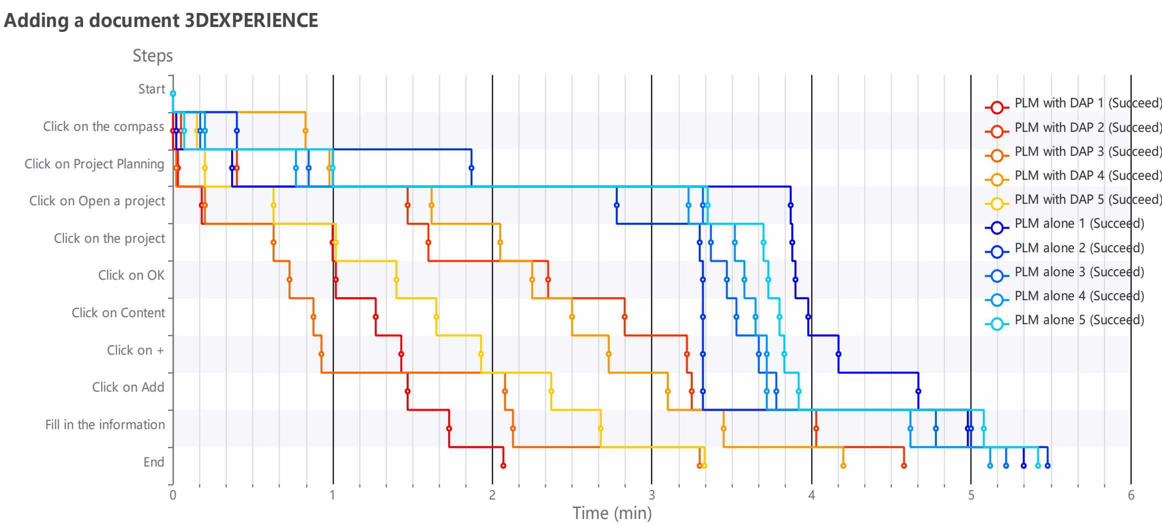


Figure 5: Example of chronograms

Through these chronograms, we can observe significant differences and specific patterns that characterize users' actions, actions that will be correlated and confirmed by video and interviews.

A first easily identifiable pattern is an abnormally long horizontal walk. In most cases, this characterizes hesitation or forgetfulness. There are 65 without assistance and 29 with. Pointing directly where to click with a DAP bubble greatly reduces hesitation.

For the last timeline, the fact that the task goes back is due to the user clicking on Release before performing the required check. This is due to a problem with the step loading which, after manual observation, could not be displayed because the button on which to click to check was not loading fast enough. The walkthrough was therefore switched to the post-verification click stage. This shows the importance of having reliable walkthroughs and a phenomenon that was confirmed during the confrontation interviews: guided users tend to lose autonomy, since this was repeated for all the participants.

A third pattern is that, after a walk, the sequence is very fast. This, according to (De Chaumont et al., 2019), characterizes an attempt to make up for previous hesitation. This leads to errors such as those seen in the evaluation of process end-products. We only get this kind of pattern without assistance. This is confirmed by the testimonials during the confrontation phase.

For these phase 4 days later, the aim is to highlight what the participant has memorized in order to identify whether the DAP has a beneficial effect on the participant's ability to learn when using it. The participant is reminded as little as possible of what he or she has done. We give him the actions he had carried out but could not remember in the following order.

In between each step, if the participant seems to remember anything, we give him a video. We ask them the following questions:

- “What did you do?”

- “Do you think you made one or more mistakes?”

- “If so, which one(s)?”

- “Did you find it difficult to carry out what you have just described, and if so, why?”

We then found that participants needed between 1 and 2 more reminders to remember the tasks they had performed. Moreover, in their explanations, they mention the impression that DAP can significantly influence their behaviour, sometimes to the detriment of critical thinking and decision-making autonomy:

Participant Test 2: “For the last process, I followed [the DAP] but didn't really read or check what I was doing with each button. If it wasn't pointing out exactly what I needed to do, I think I would have made mistakes and not even realised.”

Indeed, they all followed a walkthrough without realizing that it was not exactly identical to the task in hand. This is due to the fact that in two deployment projects, there was a discrepancy between the initial instructions on which the guidance was based, and the actual instructions once in production, as a general workflow applied to a specific PLM tool. This phenomenon is particularly problematic as it can lead to a potentially erroneous adoption. In addition, users expressed specific frustration when they realised that the walkthrough did not correspond exactly to the requested task as usual in real projects, due to the nature of guidance which cannot anticipate all paths and specifications required.

Participant Test 1: “The walkthrough should have shown that the part had to be inspected before release. Fortunately, I could go back and the part was correct, otherwise the walkthrough would have made me make a mistake.”

Some participants suggested modifying walkthroughs to intentionally diverge from the task structure, encouraging more critical engagement. Others recommended adding warnings to remind users of their responsibility and prevent passive task execution. All identified timeline patterns (e.g., hesitation, missteps) were confirmed during post-task interviews, supporting the feasibility of detecting user behavior through anchored checkpoints or walkthrough tracking. Participants also proposed improvements:

- 6 wanted a visual progress map or step numbering,
- 4 suggested adding illustrative images for clarity,
- 2 proposed a semantic search feature (e.g., chatbot) for better guidance retrieval.

Usage habits also played a role—some relied on keyboard shortcuts or preferred trackpads over mice, affecting task fluidity. Four participants sought help on YouTube, and one tried ChatGPT (without specifying the tool), highlighting potential for AI-based, context-aware assistance. Finally, 12 participants said they would validate their actions with a manager in real settings.

Generalizability and Scalability

Despite this experience, which involved only 20 participants and two PLM systems, the tasks to be performed and the software were chosen to represent universal PLM cases, regardless of the industrial sector in which they are implemented. The tasks to be performed were chosen from five different industrial projects in three different industrial sectors. At least three projects contained the selected tasks.

Future studies could specifically extend these tasks to configurations specific to different industrial sectors in order to refine the results obtained.

Threats to validity

Evaluating the usability of a Product Lifecycle Management (PLM) tool with the assistance of a Digital Adoption Platform (DAP) involves several factors that may influence the results. These considerations are essential to accurately interpret the data and validate the conclusions drawn from the study.

Although this research focused on individual task performance, the observed reductions in task completion time and improvements in accuracy suggest that DAPs could positively impact broader organizational indicators such as onboarding costs, user support requirements, and overall process efficiency. However, further longitudinal studies are needed to verify these effects over time.

One initial challenge is anticipatory learning. Users who quickly become familiar with DAP guidance may rely on it more than on their own understanding of the PLM interface. This can create a misleading impression of improved usability by masking the system's inherent complexity. As a result, it becomes difficult to assess whether user performance reflects the tool's actual usability or simply the support provided by the DAP.

Another important factor is automation bias. Users may follow the steps provided by the DAP without critical thinking, which could lead to the execution of inappropriate or inefficient workflows. This becomes particularly problematic when the DAP guidance does not fully align with an organization's actual processes. Over-reliance on guidance may reduce users' contextual awareness and critical decision-making, leading to an illusion of usability that does not reflect real-world usage conditions.

The composition of the participant sample also matters. If the group consists mainly of younger or digitally literate individuals, their experience may not reflect that of less tech-savvy users. This limits the generalizability of the findings. It is therefore important to include a broader range of user profiles, including variations in age, digital fluency, and industry experience.

Observer bias is another risk. Researchers involved in the study might, consciously or not, interpret results in ways that align with their expectations. For example, a belief in the DAP's effectiveness could lead to underreporting of user difficulties or overemphasis on positive outcomes. To mitigate this, it is crucial to rely on objective metrics and transparent methodologies.

User perception can also be distorted by the novelty effect. New technologies often elicit positive initial reactions, but these can fade as users encounter limitations. Capturing a realistic assessment of usability requires observations over longer periods.

Finally, organizational context may influence how participants report their experience. In some cases, users may feel pressured to provide positive feedback, especially if managers or researchers are present. This reluctance to express criticism can obscure genuine usability challenges.

By acknowledging these factors, the study gains a clearer perspective on its limitations and opens the door to more robust future research. Broader participant sampling, a mix of qualitative and quantitative methods, and longer-term evaluation will help achieve a more accurate understanding of how DAPs influence PLM tool usability.

5 Conclusion and future works

In conclusion, we have seen that the experimentation proposed in this study validates the hypothesis that the usability perceived by users increases with the implementation of a digital adoption platform when using a PLM tool. Similarly, we can also validate the hypothesis that the use of a DAP improves execution speed while limiting errors.

However, we also know from our interviews that users tend to remember less of the tasks they perform when using a DAP. We have seen that, according to them, this could have been improved by better construction of the walkthroughs for learning purposes rather than simplistic application of the processes. Also, poorly executed walkthroughs, if they were not completed, were perceived by users as a greater source of difficulty and frustration. This confirms the importance of keeping walkthroughs operational as the interface of the PLM support tool changes.

Cross-referencing the various measurements allowed us to assess the reliability of each evaluation method and to identify their respective limitations. In addition, as each of these tools has been implemented through a practical use case, it is possible to anticipate the technical prerequisites for each one.

Finally, future work will involve carrying out similar experiments on other types of software in order to verify these conclusions. One aim would be to integrate different Artificial Intelligence models at different levels to aid creation as well as user understanding. In addition, it would be advisable to test on a larger number of PLM tools as well as on more participants in more varied industrial contexts and uses in order to confirm and solidify these experiments.

In addition, the objective of this study was to characterize the various advantages of several measurement methods in order to measure the evolution of a DAP's efficiency through the deployment of PLM software over several years.

Statements and Declarations

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Declarations Conflict of Interest: The authors declare that three of them are affiliated with Knowmore, the company that developed the digital adoption platform studied in this paper. However, the objective of this research was not to promote the platform, but rather to evaluate its limitations and identify the best practices for its deployment. All analyses were conducted with the aim of ensuring scientific rigor and objectivity.

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