A Case Study Investigating Feasibility of VR Implementation for Training in the Pharmaceutical Industry

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Abstract: This case study explored the feasibility of implementing Virtual Reality (VR) technology as a training solution in the pharmaceutical industry, specifically focusing on Quality Control using Ultra-Performance Liquid Chromatography (UPLC) equipment. Utilizing the TELOS framework, we evaluated technical, economic, legal, operational, and scheduling aspects, revealing that VR training significantly enhances task performance, user confidence, and overall satisfaction compared to traditional methods. The economic feasibility analysis indicated a total one-time cost of 51,425.00 DKK for implementing the VR solution, with projected annual costs of 269,000.00 DKK/year for maintenance, alongside 1,249.00 FTE hours for setup and 221.05 FTE hours needed annually for support. While these findings underscore the investment required for effective VR integration and identify areas for cost optimization, challenges such as organizational changes, user adaptation, and a small sample size in the usability study may affect generalizability. The limited research on VR training in industrial contexts highlights the need for ongoing exploration. Overall, this study contributes valuable insights into the effectiveness of VR training and supports further investment in innovative training solutions to improve operational efficiency and employee development in the pharmaceutical sector.

Keywords: Virtual Reality, Feasibility, Pharmaceutical Industry, Digital Training Technology

1. Introduction

The adoption of Virtual Reality (VR) technology for training purposes has been investigated in both educational and industrial settings (Howard et al. 2021; Doolani et al. 2020; Langendorf & Khalid 2025). However, the implementation of VR training is often marked by its resource-intensive nature, raising important considerations for organizations seeking to integrate such technology effectively. The success of any innovation and technology is dependant on its desirability, viability and feasibility (Brown 2009). Industrial projects are generally focused on viability (Pabst et al. 2020), leading to a lack of empirical research investigating feasibility of innovation projects in a number of industries (Noghabaei et al. 2020). Feasibility studies investigating economic, technological and operational feasibility have been done for large scale VR implementation efforts in non-training contexts (Shelke & Chakraborty 2021), and in the context of physical or general competency training (Li et al. 2023; Park et al. 2020; Li et al. 2020; Yang et al. 2025), but has to the best of the authors knowledge not been performed in the highly regulated context of pharmaceutical production. This paper aims to address this deficiency by providing a comprehensive feasibility analysis grounded in a case study conducted at a Danish pharmaceutical firm.

2. Background

2.1 Feasibility of Industrial Training

Feasibility assesses the practicality and implementation potential of a project within existing constraints, while viability examines its long-term sustainability and economic prospects, and desirability evaluates its appeal and user demand (Brown, 2009). Various methodologies can be employed to measure feasibility, which can be categorized into multiple aspects including technical, economic, legal, operational, and schedule considerations, in addition to political factors (Hall 2008). Research on feasibility has been conducted across different industries for project management (Ibbs & Young, 2000) and for transitioning individuals from educational settings, such as universities or trade schools, into industrial positions (Kang & Kim, 2020). Furthermore, it has been explored in the context of extensive training programs within the healthcare sector (Hooley et al., 2020; Brownie &

Thomas, 2014); however, there is a notable gap in the literature regarding feasibility studies specifically focused on industrial training technology.

2.2 Feasibility of VR in Industry

Most studies investigating the potential of VR for industrial training focus on usability. Several of these studies have been carried out for operator training within highly regulated contexts such as vehicle production and maintenance (Ganier et al. 2014; Kalkan et al. 2021; Söderlund et al. 2024), pharmaceutical production (Wismer et al. 2021) and nuclear energy production (Masiello et al. 2022). Additionally other industrial studies focusing on other professions such as nurses (Zhang et al. 2022; Jeon et al. 2020) and electricians (Tanaka et al. 2023) along with students preparing to work in industry (Yang et al. 2025). While these studies all include feasibility aspects, feasibility has not been the primary focus in most cases.

2.3 History of VR at the Company

Since the 2010s, Novo Nordisk has explored the application of Virtual Reality (VR) and extended reality (XR) technologies to address training challenges (Langendorf & Khalid, 2024). The company's VR initiatives are primarily categorized into two uses: Design Use and Training Use. Design Use involves "sandboxes" that integrate 3D models, allowing teams to visualize complex configurations and identify design flaws before physical implementation. For instance, a design review in a 3D virtual environment uncovered 30 issues compared to just four in traditional assessments. These virtual spaces also enable interactions for operators and personnel at expansion sites with environments not yet physically constructed. Training Use extends from these sandboxes by incorporating defined procedures and performance monitoring systems. Several training projects are underway at Novo Nordisk, including the one presented in this paper. Additionally, experiments with Augmented Reality (AR) using Microsoft HoloLens were conducted but discontinued following Microsoft's support shutdown in late 2024. Detailed discussions on the feasibility challenges of earlier VR and AR projects will follow in this paper.

2.4 The Case

This project focuses on developing a VR training solution for Quality Control using Ultra-Performance Liquid Chromatography (UPLC) equipment, which is essential for laboratory technicians to ensure product safety. Currently, UPLC training relies on a brief instructional video and infrequent in-person sessions, leading to significant knowledge gaps and accessibility issues. New employees face considerable delays if they miss these monthly sessions, affecting both individual productivity and overall team efficiency. Therefore, there is a critical need for a more flexible and engaging training solution to improve onboarding and learning quality, justifying the allocation of resources for a VR training setup. Two different versions of a VR training setup were developed, one custom built in Unity and one built using Synergy XR.

3. Methodology

3.1 Framework

In this study, the TELOS framework will be employed as a comprehensive tool for evaluating the feasibility of digital systems. The TELOS (Technical, Economic, Legal, Operational, and Schedule) mnemonics serve to guide the investigation through varied dimensions of feasibility (Hall 2007). TELOS has been extensively utilized in digital systems evaluation (Ningsi & Nuzul 2023; Perdana et al. 2022; Avan et al. 2016). This study will focus on qualitative assessments rather than quantitative metrics, to focus on understanding each relevant aspect of feasibility without the constraints of numerical evaluation.

3.2 Technical Feasibility

Technical feasibility will be assessed through usability tests, which analyze whether the system performs as intended (Martin & Hannington 2012). The user journey has been investigated through practical tests to evaluate the system's functionality and technical aspects, ensuring that the organization possesses the necessary resources for implementation (Polaine et al. 2013).

3.3 Economic Feasibility

The evaluation of economic feasibility will follow the assessment of technical and operational feasibility, aligning with established practices in previous studies (Bause et al. 2014). Key economic metrics will encompass Total Cost of Ownership (TCO) (Ellram 1995) and Return on Investment (ROI) (Brealey 2017), both of which are critical in gauging viability of a project, but can also serve feasibility investigation purposes as in this study.

3.4 Legal Feasibility

The legal feasibility of the project will be investigated through expert assessments (Ritchie 2003) by the developers and management, which will provide insights and recommendations regarding compliance with relevant laws and regulations.

3.5 Operational Feasibility

To determine operational feasibility, usability tests employed in previous studies will be leveraged, as high usability predictors often correlate with high acceptance from users and organizations (Broderick et al. 2023; Yen & Bakken 2011; Pravitno et al. 2023). The Kirkpatrick model will be utilized to evaluate whether training aligns with organizational goals and its overall impact on performance. Additionally, user flow tests will assess whether the system can effectively integrate within existing processes, as well as ascertain the maturity of the organization's technological capabilities (Masiello et al. 2022).

3.6 Schedule Feasibility

The schedule feasibility assessment will also rely on expert assessments (Ritchie 2003) by the developers and management, providing an informed outlook on the practicality of project timelines and deadlines in relation to organizational objectives and resource availability.

3.7 Additional Data Collection

Key findings from previous VR projects at the company were collected through interviews with responsible project managers (n=3) (Ritchie 2003). These findings along with the legal and schedule feasibility analysis will be included in the discussion section.

4. Results

4.1 Technical & Operational Feasibility

4.1.1 Usability Testing

The usability evaluation included three groups of five laboratory technicians in each who had no prior process experience, with each group receiving training through one of the following methods: the existing classroom setup, a custom virtual reality (VR) solution, and a VR solution built on an established platform. The assessment criteria encompassed task performance, user satisfaction—measured using the Usability Metric for User Experience (a shortened version of the System Usability Scale)—and post-training confidence. The results revealed that participants trained with VR achieved task completion rates of 8.4/9 and 7.2/9 for the two VR setups, significantly surpassing the 2/9 completion rate of the classroom-trained group. Furthermore, the confidence levels of the VR-trained groups were notably higher (8/10 and 7.4/10) compared to the classroom group (3.4/10). Although no significant differences were detected in training duration, the statistical analysis indicated that the VR training methods are more effective than the traditional classroom approach. Performance between the two VR solutions showed no significant difference. Satisfaction scores for the VR groups were higher (85 and 82.5) in comparison to the classroom group (67.2), though these differences were not statistically significant. Given the limited sample size and lack of long-term impact evaluation, these findings provide initial insights into potential performance improvements, but did find significant difference in performance between the two VR solutions. Due to the faster development process involved with the Synergy XR solution, this option was selected for continued economic feasibility investigation.

4.1.2 User Journey (Practical Tests)

4 iterations of the setup were developed and tested with users. Throughout this iterative process of the VR training solution, several key challenges were identified:

1. Access and Navigation Issues:
    - Challenge: Users struggled with accessing training materials on SharePoint (internal platform) and found the navigation confusing, particularly with videos opening in new tabs.
    - Solution: Subsequent iterations focused on streamlining access to information, and the eventual transition to Degreed (LMS) aimed to create a clearer, step-by-step user flow.
2. Overwhelming Information:
    - Challenge: The initial training content was perceived as overly complex, resulting in user confusion and difficulty in comprehension.
    - Solution: Iterative feedback led to the simplification of instructional materials and the consolidation of content into an intuitive e-learning module using Articulate Storyline 360, reducing information overload.
3. Language Barriers:
    - Challenge: Training materials primarily in Danish posed challenges for non-Danish speaking users.
    - Solution: New video content was created in English to accommodate non-Danish speakers, broadening accessibility.
4. User Support and Training Setups:
    - Challenge: Users expressed a strong desire for in-person assistance during training sessions due to uncertainties in using VR technology.
    - Solution: The introduction of VR supervisors for 1:1 training sessions provided hands-on support, enhancing user confidence and ensuring a smoother onboarding process.
5. Booking Confusion:
    - Challenge: The original booking process for VR rooms caused considerable confusion among users.
    - Solution: Clearer guidelines were established for booking procedures, and users were encouraged to use familiar software, such as Outlook, for scheduling.

The findings from each iterative testing phase emphasized the importance of user feedback, leading to significant changes in training delivery and structure. This approach resulted in the development of an effective VR training solution flow, shown in figure 1. The final version of the room utilized for the training can be seen in figure 2. In regards to technical aspects, the Meta Quest 3 headset was chosen for its superior rendering capabilities and ability to maintain a stable frame rate, which effectively minimizes discomfort and enhances the overall virtual reality experience. In addition to the headset, several supporting tools were integrated to improve the training environment and gather user insights. Microsoft Forms was utilized for collecting feedback, while Degreed served as a tracking system for learning activities. Furthermore, design software such as Canva, Fusion 360, and Blender contributed to the development of engaging training materials. Although the HTC Vive was initially considered for its high rendering capabilities, it was ultimately set aside in favour of the Meta Quest 3 due to its more user-friendly implementation.

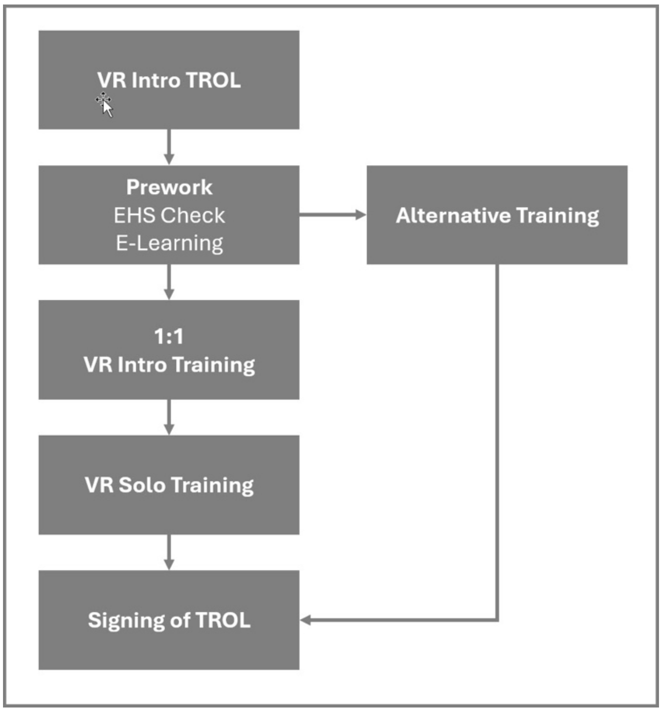

Figure 1: VR Training Flow

Figure 2: VR Room Setup

4.2 Economic Feasibility

4.2.1 Total Cost of Ownership

This calculation is based on the assumption of having a total of 2 builder licenses (the integrated license plus 1 additional builder license) and 1 active VR room with 15 users for training each year. Additionally, it assumes the acquisition of 4 VR headsets—2 for use in the VR room and 2 for development and testing purposes.

Direct Costs:

- SynergyXR License: 224,000.00 DKK/year for 2 builder licenses and 100 users.
- Extra Builder Licenses: 45,000.00 DKK/year for each additional builder license.
- VR Headsets (with elite strap and accessories): 18,200.00 DKK for 4 units.
- UV Cabinet: 32,725.00 DKK for one unit used for equipment sterilization.

- Charging Station: 500.00 DKK for one unit.
- Development Cost: 1,224 FTE hours for content preparation and testing.
- Installation Cost: 25.00 FTE hours for setting up the training room.
- Maintenance and Support: 100.00 FTE hours/year for ongoing support.

Indirect Costs:

- Ambassador-Related Activities: 129.00 FTE hours/year for 3 ambassadors, covering both training and related activities.
- Downtime: 10.05 FTE hours/year for training time per trainee (estimated at 15 trainees).

Intangible Costs:

- Employee Productivity Loss: 0.00 FTE hours/year; no expected loss in productivity.
- Compliance Risks: 0.00 FTE hours/year; deemed non-relevant as it is Non-GxP.

Environmental Considerations:

- CO_2 Emissions from Development: 257.04 kg CO_2 (fixed).
- CO_2 Emissions from VR Equipment: 443.48 kg CO_2/year for one active training room.
- Total CO_2 Savings from Travel: 511.25 kg CO_2/year from saved travel (1 flight per VR room).
- Net Total CO_2 Emissions: 189.27 kg CO_2/year.
- Projected Net Total CO_2 Emissions (after one year): -67.77 kg CO_2/year.

Summary:

- Total One-Time Costs: 51,425.00 DKK
  This includes all one-time expenses associated with the implementation of the VR training solution.
- Total Annual Costs: 269,000.00 DKK/year
  This encompasses all recurring costs required for maintaining the VR training system annually.
- Total One-Time FTE Hours: 1,249.00 FTE Hours
  This reflects the total full-time equivalent hours allocated for the initial setup and development of the VR training solution.
- Total Annual FTE Hours: 221.05 FTE Hours/year
  This represents the estimated total full-time equivalent hours required for ongoing maintenance and operational support of the VR training solution each year.

4.2.2 Return on Investment

The Return on Investment (ROI) calculation evaluates the potential performance metrics associated with implementing enhanced training solutions for Ultra-Performance Liquid Chromatography (UPLC) processes within this part of the organization, focusing on data for the year 2024. This analysis is grounded in several key assumptions: 1). Of the total 873 re-runs recorded in 2024, 673 are attributed to equipment failure, which can potentially be mitigated through the implementation of VR training. 2). It is assumed that 15% of these re-runs (approximately 101) are caused by human mishandling of equipment, a figure derived from consultations with multiple Subject Matter Experts (SMEs). 3). On average, a Full-Time Equivalent (FTE) employee spends an additional 6 hours on each re-run.

- Status Quo: The current UPLC training processes lead to 606 FTE hours required annually for re-runs, with 101 re-runs and 66 equipment breakdowns each year.
- Minor Change (2.5% Improvement): With minimal adjustments, re-run hours decrease to 591 FTE hours, resulting in 98 re-runs and 64 breakdowns.
- Moderate Change (5% Improvement): Further enhancements reduce re-run hours to 576 and the number of re-runs to 96, alongside 62 breakdowns.
- Significant Improvement (10% Improvement): Substantial upgrades yield 545 FTE hours saved on re-runs, 91 total re-runs, and 59 breakdowns annually.
- High Improvement (15% Improvement): Improved training approaches potentially save 515 FTE hours for re-runs, with 86 re-runs and 56 breakdowns.
- Maximal Improvement (20% Improvement): The best-case scenario predicts a decrease to 485 FTE hours, 81 re-runs, and 52 breakdowns each year.

4.3 Legal & Schedule Feasibility

The legal and scheduling aspects were deprioritized as they were not applicable to this project. Management did not establish a specific timeline since the project also had an exploratory purpose. The issues with the current training program were so significant that no timeline requirements were imposed on the project team. The pilot was developed over a six-month period during which hardware and software were selected, and the technical competencies needed to create the complete instructional materials were established. Following this design and development phase, scaling the instruction to include the entire training framework was estimated to require an additional four months. The VR training serves as a substantial enhancement to the existing training setup without altering the underlying Standard Operating Procedures (SOP) or Job Instructions (JI). Since all participants are company employees obligated to complete this training and no personal information would be collected on them, no GDPR concerns were identified, leading to the conclusion that there would be no legal challenges.

5. Discussion

5.1 Comparison to Previous Projects at the Company

Feasibility challenges for VR and AR projects at Novo Nordisk, identified through stakeholder interviews, include various technical, organizational, and user-related issues. Technical limitations of devices like the Hololens affected performance, with users experiencing frustrations from calibration difficulties and 3D model rendering errors.

Organizationally, the complex device enrollment process created significant barriers; it was more intricate than for traditional PCs, complicating compliance and enterprise readiness. Security transitions requiring multi-factor authentication further hindered operator accessibility. User acceptance was affected by perceptions of wearing AR or VR headsets as a weakness, leading to reluctance in engaging with VR and AR training. Additionally, inconsistent training resources and the need for super users to assist with onboarding complicated implementation.

Logistical challenges included managing inter-team communication and ensuring all technical aspects met user requirements. Overall, the combination of technological constraints, procedural complexities, and the necessity for user acceptance highlighted the need for sustained effort for successful integration.

5.2 Comparison to Previous Studies in Industry

Due to the limited number of studies in general investigating the use of VR for training in industry (Langendorf & Khalid 2025), the amount of studies we can compare to is limited. A previous study focusing on industrial assembly tasks for factory workers found a 27.9% improvement in performance, and 89% reduction in assembly flaw rate (Kalkan et al. 2021), when compared to peer training. A previous study carried out at Danish trade schools specializing in pharmaceutical production operators found a significant improvement in theoretical knowledge, perceived learning, practical skills and self efficacy when compared with traditional SOP reading (Wismer 2021), but found that on multiple parameters peer training outperformed the VR setup. In the context of vehicle maintenance training, participants who underwent both conventional and virtual training demonstrated comparable performance levels when tasked with executing procedures in actual environments. According to Ganier (2014), both training methods resulted in improved outcomes regarding successful task completion, efficiency in task execution times, the duration spent referring to job instructions, and the frequency of instructor guidance provided. Aligning with these findings, our usability evaluation revealed significant improvements in task performance for VR-trained participants, who achieved task completion rates of 8.4/9 and 7.2/9 for the VR solutions, far exceeding the classroom-trained group's rate of 2/9. Additionally, similar to Wismer's results, we observed enhanced confidence levels among VR-trained individuals, indicating a positive impact on their perceived readiness for work. This suggests that, despite mixed results in comparison to peer training noted in other studies, the effectiveness of VR training in fostering essential skills and confidence cannot be overlooked.

One feasibility study investigating the potential for construction safety training found that VR training significantly improves students' performance across all measured outcomes (Yang 2025), emphasizing its effectiveness in enhancing safety awareness and operational skills. Additionally, the reduction in variability among students' learning outcomes suggests that VR training promotes consistent performance, which is crucial for educational equity. Furthermore, students scoring higher in self-evaluation showed increased motivation and engagement with VR technology compared to their peers.

5.3 Sources of Error

The pioneering nature of this project within the company introduces potential sources of error, particularly in speculative economic estimates that may not accurately reflect future conditions due to limited historical data. Ongoing organizational changes, such as expansion and reorganization, could significantly alter workflows and challenge initial resource assumptions. Additionally, the small sample size in the usability study limits the ability to generalize findings and may overlook diverse user needs, affecting the assessment's accuracy. Rapid technological integration may also lead to adaptation challenges for inexperienced users, impacting usability ratings. To mitigate these issues, ongoing research, a larger participant base, and continuous reassessment of the project's feasibility are essential as it progresses.

5.4 Future Work

To enhance the virtual training initiative, it is essential to finalize the training setup, ensuring all components are fully operational and integrated. Conducting a large-scale study will allow for the assessment of the VR training solution's impact on performance metrics across a wider user base. Additionally, evaluating the long-term viability of the VR training will be crucial for understanding its sustainability and adaptability to future changes. Finally, ramping up the training setup across the organization is necessary to provide all employees with access to this innovative training method, ultimately fostering skill development and improving operational efficiency.

6. Conclusion

This case study has explored the feasibility of implementing Virtual Reality (VR) technology as a training solution within the pharmaceutical industry, specifically focusing on Quality Control using Ultra-Performance Liquid Chromatography (UPLC) equipment. By employing the TELOS framework, we assessed technical, economic, legal, operational, and schedule aspects, leading to valuable insights on the practicality of VR training within a highly regulated environment. Our findings indicate that VR training significantly enhances task performance, user confidence, and overall satisfaction compared to the current training setup. The economic feasibility analysis revealed a total one-time cost of 51,425.00 DKK for the implementation of the VR training solution and projected total annual costs of 269,000.00 DKK/year for ongoing maintenance. The analysis also indicated a total of 1,249.00 FTE hours for setup and development, along with 221.05 FTE hours required annually for support of the approximately 1 hour long instruction. These findings underscore the investment required for successful VR integration while highlighting potential areas for cost optimization as the program matures. Despite the promising results, challenges such as organizational changes, user adaptation, and the small sample size of the usability study highlighted potential sources of error that could affect the generalizability of our findings. The lack of extensive prior research in VR training for industrial contexts further emphasizes the need for ongoing exploration in this area.

Ethics Declaration

No ethical clearance was necessary.

AI Declaration

Scite.Ai was used for identifying related works. ChatGPT was used to assist with writing in the form of rephrasing, corrections and shortening of paragraphs.

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