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Modeling the Dynamics of Management Commitment to Dojo Training Center using the System Dynamics Approach

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Abstract

This study examines the dynamics of implementing Dojo training centers in the manufacturing industry and how management commitment influences these dynamics. Dojo training centers are recognized for their structured approach to enhancing employee skills, which can significantly improve operational efficiency. Utilizing the system dynamics approach, the study employs a methodology that models how different components within a manufacturing training system interact and influence each other over time. The modeling and simulation process uses the software tool Vensim, which allows the construction, simulation, and analysis of system dynamics models of the training system. The findings indicate that as management commitment to training increases, there is a corresponding increase in the conversion of new or unskilled workers to skilled workers, leading to an increase in profit and target revenue ratio. In particular, an 80% management commitment to training is identified as the optimal solution for achieving a steady increase in profit and target revenue ratio. The key conclusion drawn from this research is that management commitment directly and significantly impacts the overall performance of a manufacturing organization employing Dojo training centers. The study emphasizes the importance of using the system dynamics approach in training program evaluation and resource allocation decisions, which enhances operational efficiency and maximizes profitability in the manufacturing industry.

Keywords
System Dynamics, Dojo Training Center, Management Commitment to Training

Introduction

1.1 Introduction to Dojo Training Centers

Dojo training centers play a crucial role in developing and enhancing technical skills in the manufacturing industry. These centers provide a structured and systematic approach to training, focusing on process development, skill improvement, and production planning. The effectiveness of Dojo training centers in equipping assembly line personnel with the necessary technical skills has been widely recognized and researched. Learning by simulation can be very effective because learners can test the effects of various decision parameters on natural and artificial processes in a controlled environment (Kotir et al. 2024). In recent years, there has been a growing interest in incorporating Industry 4.0 technologies into the training and development of manufacturing industries. These technologies, such as virtual and augmented reality, can significantly enhance the learning experience for individuals in the manufacturing industry by providing realistic industry simulations and interactive training exercises.

1.2 System Dynamics Approach to Dojo Training Centers

The system dynamics approach offers a valuable framework for understanding and analyzing the impact of the manufacturing industry dynamics and Dojo training centers. System dynamics is a methodology that studies how different components within a system interact and influence each other over time (Ojha et al. 2014; Zhao et al.2023). By modeling the training processes and their impact on the manufacturing industry, system dynamics can provide insights into the long-term effects of Dojo training centers on improving productivity, reducing errors, and enhancing overall operational efficiency in manufacturing industries. System dynamics models can capture the complex relationships and feedback loops among various factors, such as training effectiveness, skill improvement, production planning, and operational performance. This approach allows for a holistic assessment of the training system and its impact on the manufacturing industry.

Furthermore, by incorporating feedback loops and considering the dynamic nature of manufacturing integration, system dynamics can reveal additional manufacturing capabilities and help identify areas for improvement. Incorporating the system dynamics approach into the evaluation and improvement of Dojo training centers can lead to better decision-making and resource allocation. Decision-makers can simulate different scenarios and assess the expected impact of training initiatives on the overall system performance.

1.3 Understanding System Dynamics in Manufacturing

Understanding system dynamics in the manufacturing industry is crucial for effective decision-making and resource allocation. With manufacturing systems' complex and interconnected nature, a system dynamics approach allows for a comprehensive analysis of how different variables and factors interact and influence the system's overall performance. By utilizing system dynamics modeling, decision-makers can gain insights into the long-term effects of various interventions, such as implementing Dojo training centers. This modeling technique considers the system's dynamic behavior and helps identify the potential consequences of different actions (Nazarian-Jashnabadi et al.2023). Moreover, system dynamics models enable decision-makers to evaluate the effectiveness of Dojo training centers in improving productivity, reducing errors, and enhancing overall operational efficiency in manufacturing industries.

System dynamics models provide a holistic assessment of the training system by considering feedback loops and the complex relationships among various factors, such as training effectiveness, skill improvement, production planning, and operational performance. This holistic view allows decision-makers to identify interdependencies and understand how changes in one aspect of the system can impact other areas. Through system dynamics modeling, decision-makers can explore the relationship between training effectiveness and skill improvement. It can simulate different scenarios to determine the optimal training approach that will result in the most significant advancement in skill levels. By understanding the dynamics of skill development, decision-makers can allocate resources more effectively and make informed decisions on training strategies. In addition, system dynamics modeling can help decision-makers evaluate the impact of Dojo training centers on production planning and operational performance. By capturing the complexities of the manufacturing system, the models can provide insights into how training initiatives affect production capacity, lead times, and overall system efficiency. This information is invaluable for making data-driven resource allocation and process optimization decisions.

Furthermore, system dynamics modeling can be utilized to assess the long-term financial implications of implementing Dojo training centers. By considering factors such as the cost of training programs, potential savings from improved productivity, and the return on investment, decision-makers can quantify the economic benefits of incorporating Dojo training centers into their manufacturing operations. The integration of multiple sources of data can enhance the accuracy and reliability of system dynamics models. By incorporating data from sources such as employee performance records, training evaluations, and production metrics, decision-makers can ensure that their models are grounded in real-world information. These models can then be used to validate the effectiveness of the Dojo training center and make evidence-based decisions regarding its implementation and refinement.

System dynamics modeling can also help identify potential bottlenecks or areas of improvement within the training system. By analyzing the feedback loops and dynamic relationships, decision-makers can pinpoint inefficiencies and make targeted interventions to enhance the overall effectiveness of the training program. This may include adjusting the curriculum, modifying delivery methods, or implementing additional support systems to address specific skill gaps or challenges.

1.4 Vensim: A Tool for Modeling and Simulation

Decision-makers can utilize tools such as Vensim to facilitate the process of system dynamics modeling and

simulation. Vensim is a software tool designed to build, simulate, and analyze system dynamics models. Vensim provides a user-friendly interface, allowing decision-makers to construct and manipulate models efficiently. With just a few clicks, its drag-and-drop functionality enables the creation of model elements, such as stocks, flows, and feedback loops. Decision-makers can also define variables, equations, and parameters, allowing for a comprehensive representation of the training system. The software also facilitates the simulation of different scenarios and what-if analyses. Decision-makers can explore how variables, such as training duration, training intensity, or budget allocations, impact the overall performance of the Dojo training center. By running simulations, decision-makers can assess the potential outcomes of different decision options and evaluate their effectiveness in achieving the desired goals.

The ability of Vensim to simulate dynamics is precious in the context of training programs. Decision-makers can observe how the system responds to changes over time and identify potential delays or feedback loops that might hinder the success of the training center (Galbraith 2009). This insight allows for proactive decision-making and adjustments to ensure a smooth implementation and ongoing improvement of the training program. Additionally, Vensim offers features that enable decision-makers to conduct sensitivity analysis and optimization. Sensitivity analysis allows decision-makers to assess the impact of varying input parameters on the overall performance of the training system. This analysis helps to identify which variables have the most significant influence on the outcomes and allows decision-makers to prioritize their efforts accordingly.

Furthermore, Vensim's optimization capabilities allow decision-makers to find the best combination of inputs that will maximize the performance of the training system. Decision-makers can set constraints and objectives, and Vensim will automatically search for optimal values of the input parameters to achieve those objectives. This feature is particularly useful in resource allocation scenarios, where decision-makers need to determine the optimal allocation of limited resources, such as time or budget, to maximize the effectiveness of the training program. Another advantage of using Vensim is its data-handling capabilities. Decision-makers can easily import and analyze data from various sources to inform their modeling and simulation exercises. This allows for a more accurate representation of the training system and enhances the validity and reliability of the results. Moreover, Vensim's application interfaces provide decision-makers with additional flexibility and functionality.

These interfaces allow seamless integration with other software tools or data sources, enabling decision-makers to incorporate real-time data or external models into their simulations. This integration capability enhances the accuracy and relevance of the simulation results, as decision-makers can account for the dynamic and interconnected nature of the training system. In addition to its technical capabilities, Vensim offers a user-friendly interface that makes it accessible to a wide range of users. The software utilizes natural language, eliminating the need for users to learn new computer syntax. Instead, users can input their commands and instructions using everyday language, making it easier for individuals with varying technical expertise to utilize the software effectively. Vensim also incorporates direct manipulation techniques, allowing users to interact with the system more intuitively and visually appealingly. With direct manipulation, users can directly manipulate objects or elements within the simulation model, seeing immediate feedback and results. This enhances user experience and promotes a deeper understanding of the training system and its behavior.

1.5 Management Commitment to Training

In running the model, Vensim plays a crucial role in providing the platform for creating dynamic models that simulate the behavior of complex systems over time. This capability enables the Dojo Training Center to comprehensively assess the impact of management commitment on profit and performance. By utilizing Vensim's powerful features for model development and analysis, the training center can gain valuable insights into the interconnected components that influence its operations.

2. Literature Review

Investing in training and continuous development is essential for organizations to optimize the benefits of automation and robotics-based manufacturing processes. Education and training have enhanced performance in complex manufacturing environments (Prosman & Cagliano 2022). Therefore, manufacturing industries must prioritize ongoing training and skill development to ensure the continued success and efficiency of their operations. To establish a Dojo training center for manufacturing industries, it is crucial to consider the specific needs and requirements of the industry. After reviewing the assessments of Dojo training in manufacturing, it is evident that its implementation has several beneficial effects (Catimbang 2019). The cost assessment highlights the potential for eliminating waste and increasing awareness of the manufacturing process, leading to cost savings and process improvements. Additionally, the delivery assessment reveals that Dojo training positively affects the efficiency and effectiveness of the manufacturing process, ultimately leading to the timely delivery of products and increased customer satisfaction.

3. Methodology

A system dynamics approach can be utilized to understand further the dynamics of establishing a Dojo training center for manufacturing industries. System dynamics is a methodology that allows for the analysis and modeling of complex systems to understand and predict their behavior over time. By applying system dynamics, we can examine the factors and feedback loops involved in establishing a Dojo training center and their potential impacts on manufacturing industry performance. The first step in creating a system dynamics model for establishing a Dojo training center is identifying the key variables and their relationships. These variables may include the number of skilled workers, new or unskilled workers, skill acquisition, profit, management's commitment to training, and overall performance metrics such as productivity, efficiency, and quality or overall equipment effectiveness (OEE). In addition to the systemic approach, it is crucial to consider the human element in implementing a Dojo training center in manufacturing industries. As evident from the assessment, the impact of Dojo training on technical skills, efficiency, and quality is directly linked to the workforce. Therefore, evaluating the employees' readiness and receptiveness to the training program is essential.

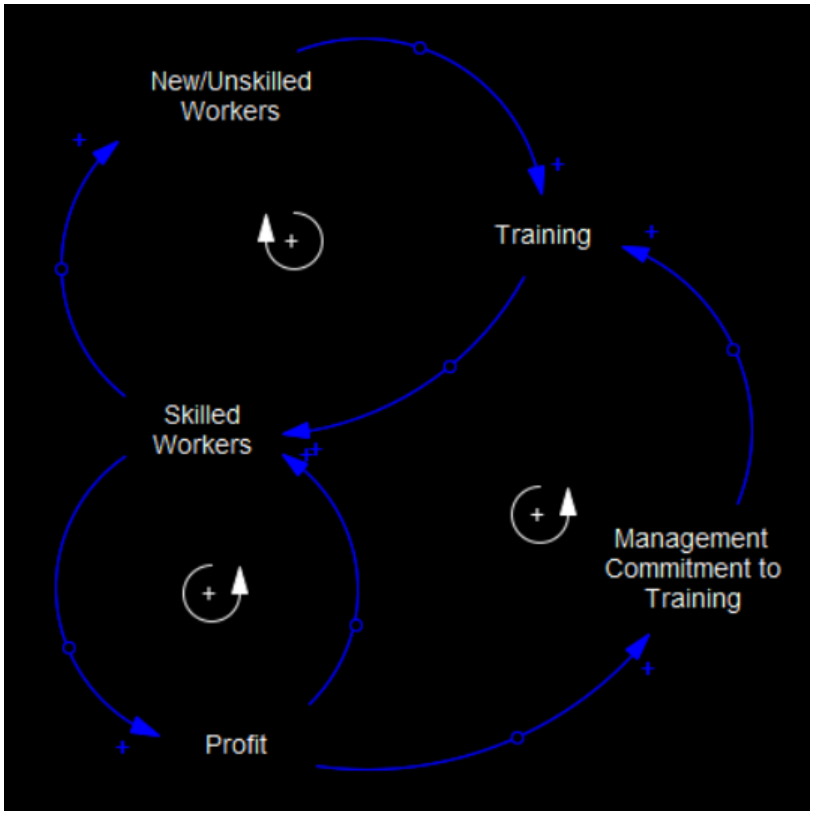

Figure 1. Causal Loop 1. Employee Training, 2. Management Commitment to Training, and 3. Profit.

The causal loop diagram illustrates the interconnected relationship between employee training, management commitment to training, and the resulting impact on profit. This holistic approach to modeling the impact of the Dojo training center takes into account both the technical and human aspects, providing a comprehensive understanding of the system dynamics involved. The system dynamics approach offers valuable insights into the nonlinear dynamical characteristics of the manufacturing industry. By incorporating feedback loops and analyzing the dynamic nature of manufacturing integration, decision-makers can better understand the potential impacts and challenges associated with establishing the Dojo training center.

Manufacturing systems' dynamic and interconnected nature requires a comprehensive analysis of the feedback loops and complex relationships involved. The Vensim modeling tool is instrumental in providing decision-makers with the capabilities to simulate and analyze the multifaceted interactions within the training system, enabling proactive decision-making and resource allocation.

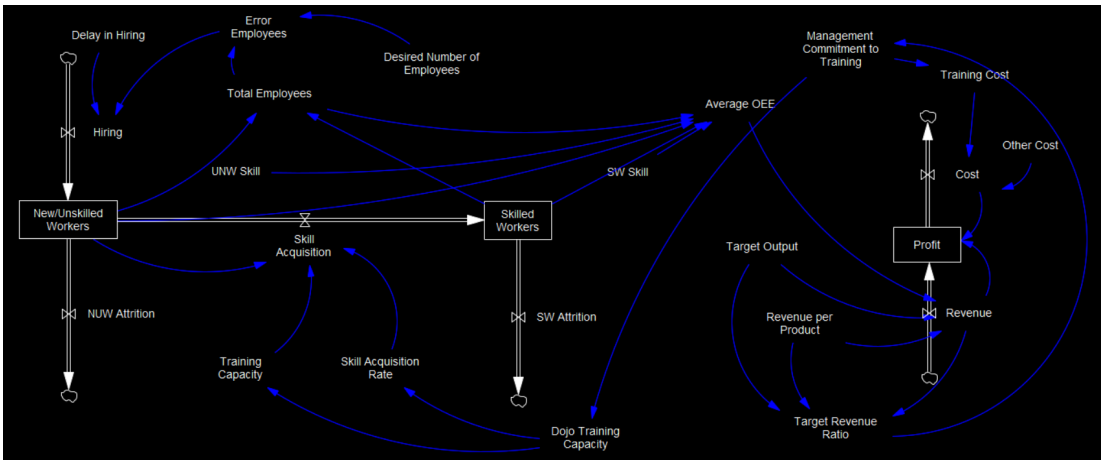

Figure 2. Stock Flow Diagram

4. Results and Discussion

A thorough analysis of the implementation process using Vensim and System Dynamics methodology shows that the integrated approach has significantly contributed to the sustainability and operational effectiveness of the Dojo Training Center. The insights derived from the dynamic models, causal relationships, and scenario analysis tools have been pivotal in informing sustainable decision-making processes and aligning training strategies with the center's broader objectives.

Figure 3. Base: 20% Management Commitment to Training

Figure 3 shows no conversion of new or unskilled workers to skilled workers in 60 months or five years with 20% management commitment to training. Increasing the management commitment to 30%, 40%, 50%, and 80%, shown in Figures 4, 5, 6, and 7, respectively, demonstrates a conversion of new or unskilled workers to skilled workers and accelerates it as the management commitment to training increases. Figure 8 depends on the feedback loop based on the target revenue ratio due to an increase or decrease in revenue. The result in Figure 6 and 7 show similarity and results; thus, 80% commitment to training is the optimal solution to the problem. Figure 9. shows an increase in profit as the management's commitment to training increases. This shows a direct impact or relationship between commitment and the organization's overall performance.

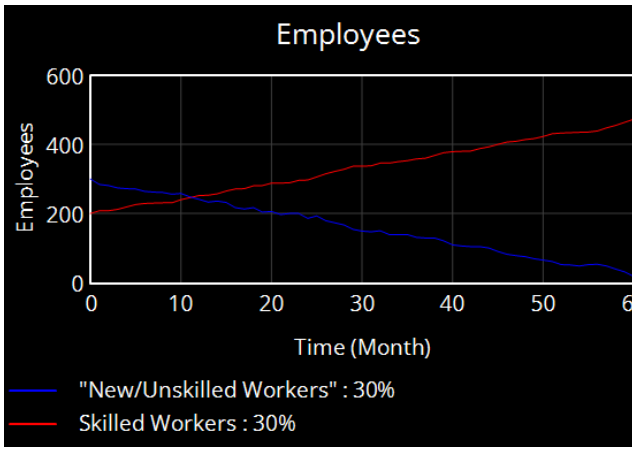

Figure 4. Adjusted: 30% Management Commitment to Training

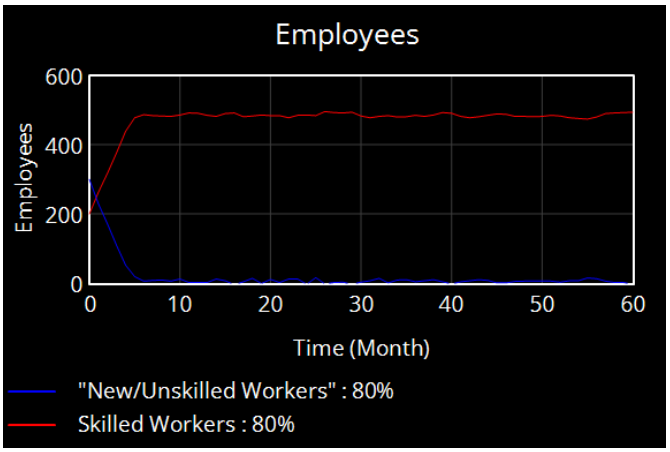

Figure 7. Adjusted: 80% Management Commitment to Training

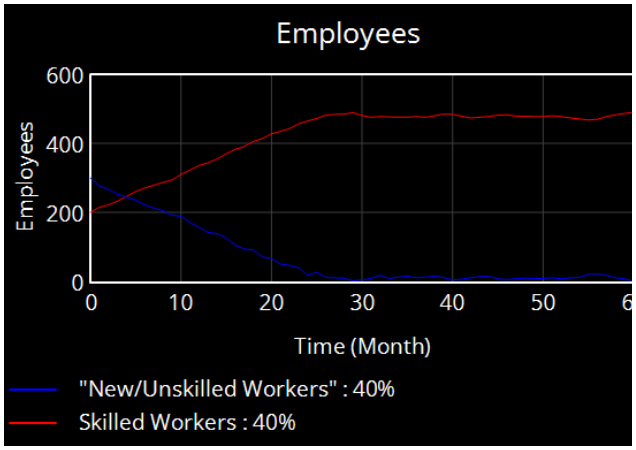

Figure 5. Adjusted: 40% Management Commitment to Training

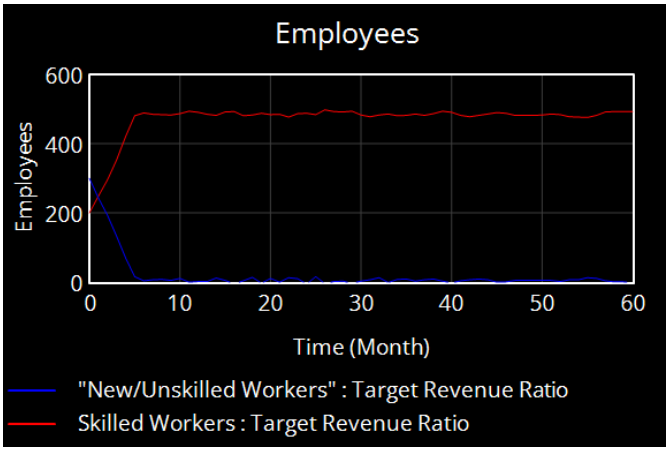

Figure 8. Adjusted: Management Commitment to Training equal to Target Revenue Ratio

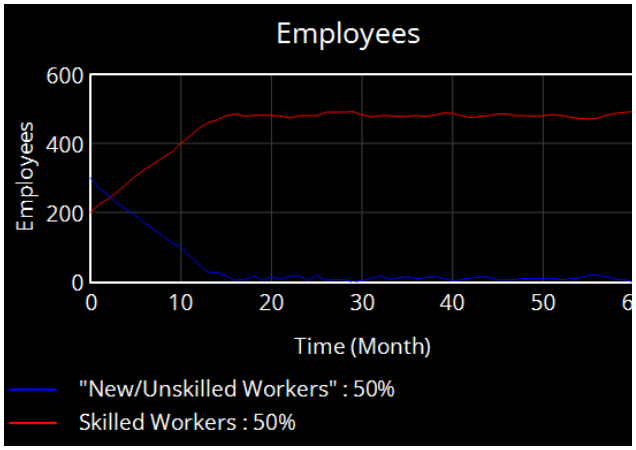

Figure 6. Adjusted: 50% Management Commitment to Training

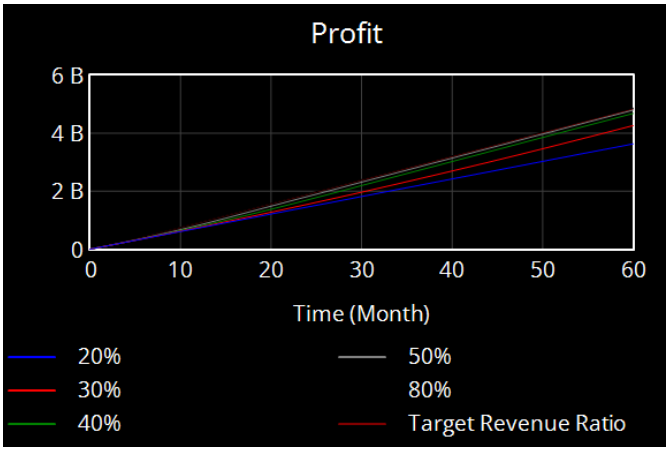

Figure 9. Profit Comparison Based on Different Management Commitment to Training

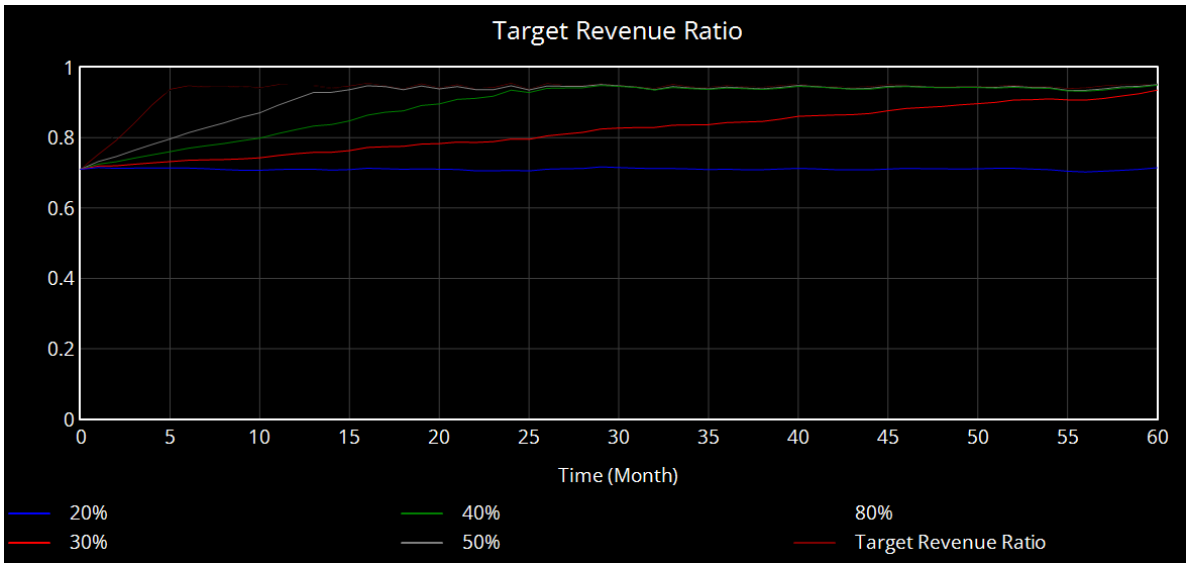

Figure 10. Target Revenue Ratio Based on Different Management Commitment to Training

Figure 10. illustrates an increase in the target revenue ratio compared to the organization's actual performance. 20% Commitment to training results in a 71.46% target revenue ratio at the end of the 60th month of simulation. 30% Commitment to training demonstrates a continuous increase in the target revenue ratio from 71% in the 1st month to 93.53% in the 60th month. 40% Commitment to training demonstrates a continuous increase in target revenue ratio from 71% in the 1st month and reaches its peak in the 24th month with a 94.75% target revenue ratio. 50% Commitment to training demonstrates a continued increase in target revenue ratio from 71% in the 1st month and peaked in the 16th month with a 95.33% target revenue ratio. Lastly, 50% Commitment to training demonstrates a continuous increase in the target revenue ratio from 71% in the first month. It peaked in the fifth month with a 94.5% target revenue ratio. This result can determine how management reacts to different product types. Organizations with slow-moving and non-developing products may commit to training with a 30% commitment. In contrast, fast-moving and continuously evolving products should commit to 80% commitment to training to remain competitive in the market and maximize the full potential and revenue an organization can obtain.

The holistic analysis of the impact of training on profit and performance, in conjunction with the management's commitment to training, underscores the importance of leveraging Vensim and System Dynamics methodology in ensuring the success of Dojo Training in the manufacturing industry. By embracing this approach, the Dojo Training Center can proactively adapt its training programs to meet evolving sustainability goals, optimize profitability, and foster long-term operational success. The Dojo Training Center must continue harnessing the power of Vensim and System Dynamics methodology to refine its training strategies and integrate sustainable practices into its operational framework. This iterative approach will enhance the center's operational resilience and position it as a frontrunner in sustainable manufacturing practices.

References

Catimbang, L. S. M. , The Effectiveness of the Dojo Training Center in Improving the Technical Skills of the Assembly Line Personnel of Company XYZ. *Ascendens Asia Journal of Multidisciplinary Research Conference Proceedings*, *3*(3), 2019. https://ojs.aaresearchindex.com/index.php/aajmrcp/article/view/674

Galbraith, P.,System dynamics: A lens and scalpel for organizational decision making. *51st Annual Conference of the Operational Research Society 2009, OR51*, 124–145, 2009. https://doi.org/10.1057/ori.2010.3

Kotir, J. H., Jagustovic, R., Papachristos, G., Zougmore, R. B., Kessler, A., Reynolds, M., Ouedraogo, M., Ritsema, C. J., Aziz, A. A., & Johnstone, R. (2024). Field experiences and lessons learned from applying participatory system dynamics modelling to sustainable water and agri-food systems. *Journal of Cleaner Production*, *434*, 140042. https://doi.org/10.1016/J.JCLEPRO.2023.140042

Nazarian-Jashnabadi, J., Rahnamay Bonab, S., Haseli, G., Tomaskova, H., & Hajiaghaei-Keshteli, M. , A dynamic expert system to increase patient satisfaction with an integrated approach of system dynamics, ISM, and ANP methods. *Expert Systems with Applications*, *234,2023*. https://doi.org/10.1016/j.eswa.2023.121010

Ojha, R., K. Vij, A., & Vrat, P. , Manufacturing excellence and its critical factors : An interpretive structural methodology application. *Journal of Advances in Management Research*, *11*(3), 312–332,2014.

https://doi.org/10.1108/JAMR-06-2014-0032
Prosman, E. J., & Cagliano, R. , A contingency perspective on manufacturing configurations for the circular economy: Insights from successful start-ups. *International Journal of Production Economics*, *249*, 108519,2022. https://doi.org/10.1016/J.IJPE.2022.108519
Zhao, S., Huo, T., & Chen, L. , The influence of multi-level factors on Chinese residents' purchase decisions of green housing: A system dynamics approach. *Sustainable Cities and Society*, *99,2023*. https://doi.org/10.1016/j.scs.2023.105001

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