

Improving Employer Engagement in a Manufacturing Professional Workforce Development Program

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Abstract

In recent years, workforce recruitment and retention have become the top challenge for manufacturers across the country, creating an urgent demand for more effective professional workforce development (PWD). New PWD initiatives must be designed to meet the specific hiring needs of the manufacturing industry. Consequently, it is essential that the opinions and input of manufacturing employers be integrated into the creation and implementation of such PWD programs.

While existing workforce development literature provides general collaborative relationship frameworks that encourage educators to involve employers, there is still a lack of research guiding how to effectively engage manufacturers in the development and delivery of PWD programs. In this paper, we address this gap by studying manufacturing employers' views on their engagement in PWD programs. Specifically, we conducted a qualitative study to explore five key areas of employer engagement: oversight, program design, program delivery, recruitment and hiring, and financial/in-kind support.

Our paper aims to bridge these gaps by offering actionable insights and recommendations to increase employer involvement in both the operational and educational aspects of PWD programs. Our goal is to help build a larger, more skilled workforce to meet the growing demands of the manufacturing industry.

Keywords: Employer Engagement, Professional Workforce Development, Qualitative Study, Quantitative Measurements

1. Introduction

The manufacturing sector is undergoing a profound transformation fueled by advances in technology, automation, and global competition [1-2]. These rapid changes necessitate a workforce that is both technically proficient and adaptable to evolving tools, processes, and market demands. Workforce recruitment and retention remain the top challenge for manufacturers nationwide [3]. Professional workforce development (PWD) programs have long been pivotal in equipping employees with the skills necessary to thrive in this dynamic environment [4]. However, the success of these programs depends significantly on their alignment with the real-world needs of manufacturing employers.

To maximize their impact, PWD programs must directly address employers' hiring needs. Employers are uniquely positioned to provide critical insights into emerging trends, required competencies, and workplace challenges, which should shape the content and structure of professional development initiatives. Their perspectives must be integrated into the design and implementation of PWD programs to ensure relevance and efficacy. Employer engagement is increasingly recognized as a cornerstone of effective workforce development in manufacturing. Evidence shows that co-designed programs are more likely to align with industry-specific requirements and deliver measurable outcomes [5].

While existing literature provides general frameworks for fostering collaborative relationships [6], there is a noticeable gap in research addressing systematic methodologies for engaging manufacturing employers in PWD programs. For example, Valiente Bermejo and colleagues [5] emphasize the well-recognized advantages of collaboration in curriculum design and delivery but note that existing models often lack sufficient concreteness for practical application or generalizability beyond their original disciplines. Similarly, a study by the National Institute of Standards and Technology (NIST) [7] emphasizes the need for practical strategies to foster collaboration between employers and educational institutions. This gap calls for research into scalable and systematic methodologies tailored specifically to the manufacturing context.

This paper addresses this research gap by exploring five dimensions of employer engagement in workforce development programs [6]: oversight, program design, program delivery, recruitment and hiring, and financial or in-kind resources. By examining these dimensions, the paper proposes a framework of strategies to strengthen collaboration between manufacturing employers and PWD programs. The analysis emphasizes how these dimensions can be applied to create programs that are both effective and adaptable, bridging the gap between industry needs and workforce capabilities. Ultimately, the paper aims to offer actionable insights for stakeholders committed to developing sustainable, impactful workforce development initiatives. Through enhanced collaboration between PWD programs and industry leaders, these initiatives can better address workforce needs while supporting manufacturers' strategic goals. Such partnerships foster a culture of continuous learning and innovation, critical for maintaining competitiveness in today's manufacturing landscape [8].

2. Literature review

2.1. Key factors encouraging employer engagement in PWD programs

Employer engagement is fundamental to aligning workforce skills with industry demands, fostering economic growth, and improving employability. By actively participating in PWD programs, employers ensure that training initiatives are relevant, impactful, and aligned with

their organizational needs. Prior work highlights two critical factors that effectively drive employer engagement in these programs: strategic partnership and customized training.

2.1.1. Strategic Partnerships: Fostering Employer Engagement in Workforce Development Programs

Strategic partnerships are pivotal in promoting employer engagement in professional workforce development programs. Collaborating with educational institutions, industry associations, and community organizations provides employers with access to tailored solutions that address workforce challenges effectively. These partnerships ensure that workforce development initiatives align closely with industry-specific needs. By working collaboratively, employers and training providers can customize curricula to address skill gaps, thereby increasing the appeal and effectiveness of such programs [9].

In addition, partnerships enable the shared use of resources, such as funding, facilities, and expertise, which reduces costs and risks for employers and enhances their likelihood of engagement [10]. Long-term collaborations also foster trust and mutual benefits, encouraging employers to invest in programs that demonstrate a commitment to sustained success [11]. Furthermore, engaging in workforce development through strategic partnerships can strengthen an employer's brand and support corporate social responsibility (CSR) objectives, creating a win-win scenario for all stakeholders involved [12].

By addressing workforce needs, optimizing resource utilization, fostering trust, enhancing CSR, and navigating policy incentives, strategic partnerships establish a collaborative environment in which the objectives of employers, employees, and educators align seamlessly. These partnerships are instrumental in significantly increasing employer engagement in workforce development initiatives.

2.2.2. Customized Training: Driving Employer Engagement in Workforce Development Programs

Educating customers about the benefits and impacts of professional workforce development programs is essential for raising employer awareness. When employers understand how these programs align with organizational goals, such as improving employee skills and boosting productivity, they are more likely to engage actively [13]. Effective training identifies skill gaps and links workforce development initiatives to specific organizational needs. Employers who see a direct connection between these programs and improved performance are more inclined to invest in them [14].

Tailored training programs designed to meet the unique needs of specific industries or employers further enhance engagement. Training customers to adapt workforce development initiatives to their own contexts fosters a sense of ownership and relevance (Eraut, 2004). Moreover, incorporating continuous feedback loops between employers and program developers ensures that these programs remain responsive to evolving workforce demands, thereby sustaining long-term engagement [15].

By integrating these elements, customized training becomes a powerful mechanism for encouraging employer engagement in workforce development programs. Together with strategic partnerships, it creates a dynamic and mutually beneficial cycle of growth, learning, and success. Let me know if you'd like additional revisions or insights.

2.2. Areas for employer involvement in PWD programs

Spaulding and Martin-Caughey identified five critical dimensions through which employers significantly contribute to and influence PWD programs [16]. These dimensions provide a robust framework for fostering collaboration between employers, educational institutions, training providers, and community organizations, with the goal of cultivating a skilled and industry-ready workforce. Furthermore, these dimensions serve as a foundation for promoting strategic partnerships, customized training, and a focus on return on investment (ROI), which are crucial for encouraging employer engagement.

Oversight: Employers play a pivotal role in guiding the strategic direction of workforce programs. This includes serving on advisory boards, providing insights into labor market trends, and ensuring that training aligns with industry standards and future needs.

Program Design: Active involvement in program design allows employers to shape curricula and training methodologies. Their input ensures that educational content is relevant, up-to-date, and responsive to the specific skills and competencies required in their sectors.

Program Delivery: Employers contribute directly to the delivery of workforce programs by offering expertise and resources. This dimension includes activities such as providing trainers, hosting on-site learning experiences, and participating in mentoring programs.

Recruitment and Hiring: Engagement in recruitment and hiring connects program graduates directly to employment opportunities. Employers collaborate in designing pathways for internships, apprenticeships, and full-time roles, creating seamless transitions from training to employment.

Financial or In-Kind Resources: Employers provide support in various forms, including direct funding, in-kind contributions, and sponsorship of training programs. This investment underlines their commitment to workforce development and strengthens the sustainability of these initiatives.

Employers' contributions in these five dimensions collectively foster stronger partnerships and more effective workforce development programs. Oversight helps cultivate strategic partnerships by aligning training programs with market needs. Employers engaging in program design and delivery support the creation of customized training solutions tailored to specific skill gaps. Involvement in recruitment, hiring, and financial or in-kind support ensures that top candidates are attracted, trained, and retained, creating a positive feedback loop that benefits both employers and employees.

This paper explores Spaulding and Martin-Caughey's five dimensions in depth, examining strategies and best practices for involving manufacturing employers in the initiation and implementation of PWD programs. This study aims to offer actionable insights for educators, policymakers, and industry leaders. Strengthening employer involvement across these dimensions will help bridge the gap between workforce capabilities and industry requirements, ultimately enhancing the effectiveness of PWD programs and supporting the long-term success of the manufacturing sector.

3. Research method

3.1. Overview

This paper presents a multi-method study aimed at exploring manufacturing employers' perspectives on their involvement in PWD programs across five key dimensions. The central research question guiding this investigation was: How do employers want to be involved in the design, development, and implementation of a professional workforce development program?

Using Berkshire Innovation Center Manufacturing Academy (BMA), a collaborative PWD program hosted in the Western Massachusetts region, as a case study, we engaged with companies that had at least one employee graduated from the program. Members of the leadership teams from four different manufacturers were recruited for the study. Each participant took part in a 30-minute semi-structured interview designed to capture their current and preferred levels of engagement in the PWD program. Table 1 lists the demographic information of the participants and their companies. We selected companies that are among small-, medium-, and large-scale and range across multiple manufacturing fields, to increase their representativeness.

Participant	Position in Company	Products	Company Scale
1	Owner	Plastic Parts	Small
2	Director of Communications	Press Printing	Large
3	Vice President of Finance and Administration	Biomedical Devices	Medium
4	Chief Operating Officer	Concrete Structure	Large
5	Director of Human Resources	Press Printing	Large

Table 1. Interview Participant and Company Demographic Information

3.2. Data collection

3.2.1. Qualitative interview protocols

The interviews consist of three main parts. All interviews were video recorded to ensure accuracy and enable detailed analysis with the IRB approval.

Initial Open-Ended Questions: Participants were first asked about their motivations for sending employees to the PWD program and their previous engagement with the program. These questions aimed to establish a baseline understanding of their involvement and perceptions.

Quantitative Assessment: A set of quantitative questions, administered through Qualtrics, was used to measure participants' current and preferred engagement levels across the five dimensions of Spaulding and Martin-Caughey's framework[16]. We designed these questions using language that closely aligns with the description and meaning of each dimension. We asked each participant to respond to these questions in real-time during the interview to facilitate immediate feedback.

Clarification and Discussion: The remainder of the interview focused on elaboration, with participants clarifying their responses and discussing how and why they would like to engage more deeply in PWD programs. This section allowed for richer, more nuanced insights into their preferences and expectations.

3.2.2. Quantitative Items and Measurement

The quantitative portion of the study included six items designed to measure engagement across Spaulding and Martin-Caughey's five dimensions: oversight, program design, program delivery,

recruitment and hiring, and financial or in-kind resources. Table 2 lists the specific items used and the dimensions the items measure. Participants rated their current and preferred levels of engagement for each item on a 5-point Likert scale: **1** - Not at all; **2** - Once during the entire program (years); **3** - Once every cohort (18~24 weeks); **4** - Once every phase (6~8 weeks); **5** - Weekly. These scales provided a quantitative snapshot of both the frequency of current involvement and the desired level of engagement. Each cohort in the referenced PWD program consists of three phases, with each phase lasting six weeks.

Item	Dimensions
1. Communicate with the PWD program about what you hope your employees will learn from the program	Oversight
2. Make suggestions to the PWD program on what content to teach in the program	Program design
3. Make suggestions to the PWD program on how the content should be delivered	Program delivery (Content)
4. Provide the PWD program with supportive teaching materials (e.g., real-world manufacturing problems/ projects that students can work on)	Program delivery (Material)
5. Offer your employees resource support (e.g., time, equipment, funding, mentorship, etc.) to work on the PWD program-issued tasks	Financial/ In-kind Resources
6. Encourage your employees to join the PWD program	Recruitment and hiring

Table 2. Quantitative Items and Associated Dimensions to Measure Current and Desired Employer Engagement

3.3. Data Analysis

Our study combines quantitative data with qualitative insights to identify patterns in employer engagement and understand the motivations behind their preferences. This dual approach ensures a comprehensive understanding of how employers perceive their roles in PWD programs and highlights opportunities for enhancing collaboration between manufacturing employers and workforce development initiatives.

We analyzed the quantitative results using both visual and statistical (paired t-test) comparisons, mindful of the relatively small sample size. We then analyzed the interview transcripts using the process coding method, focusing on employers' preferred actions and strategies for engaging in

PWD programs. This approach allowed for a detailed exploration of participants' recommended practices and their motivations for involvement.

3.4. Positionality

The primary researcher conducting this study brings unique expertise and experience, having served as a member of the development and instruction team for the referenced PWD program. This role included active involvement in designing, developing, and implementing the first three cohorts of the program. While this experience provides valuable practical insights, it also introduces potential biases that must be carefully addressed to maintain the integrity and objectivity of the research.

Feasibility vs. Preferability Bias: The researcher's close involvement in the program's operational aspects may lead to an overemphasis on the feasibility of employer engagement actions—how easily employers can participate—rather than evaluating the preferability or effectiveness of these actions in meeting broader program goals. There is a risk of prioritizing what works for the program logistics over what delivers the most value to employers and their employees.

Instructor-Centric Bias: Another potential bias arises from the researcher's dual role as an instructor and program developer. This duality may inadvertently shift the focus toward how employer engagement can simplify instructional tasks or improve program delivery from the researcher's perspective, rather than prioritizing how such engagement benefits the employer's workforce and the manufacturing sector as a whole.

The second author of this study is an academic who guided the development of the program content. He was not directly involved with the data collection but helped shape the interpretation of the data. He teaches manufacturing at the university level, but not at the workforce level.

4. Results

This section presents our findings from both our quantitative and qualitative analyses of employer engagement in PWD programs. First, we highlight the discrepancy between employers' preferred and current involvement across multiple dimensions, based on qualitative measurement data. We then explore the specific tasks and actions employers propose to foster a deeper, more meaningful understanding of their preferred engagement approaches in these programs.

4.1. Employers desire greater engagement in PWD programs

Manufacturers consistently voiced a desire for greater involvement in PWD programs across multiple dimensions. As shown in Figure 1, they generally seek higher engagement than their current levels, especially in areas beyond simply providing resources to employees. Figure 1 illustrates the gaps between desired and current engagement for the five participating manufacturers (A–E). A positive bar signifies the manufacturer’s intent to increase its involvement in the PWD program. Each cluster corresponds to a specific dimension in Spaulding and Martin-Caughey’s framework [16], highlighting how employers’ preferred and current engagement levels compare.

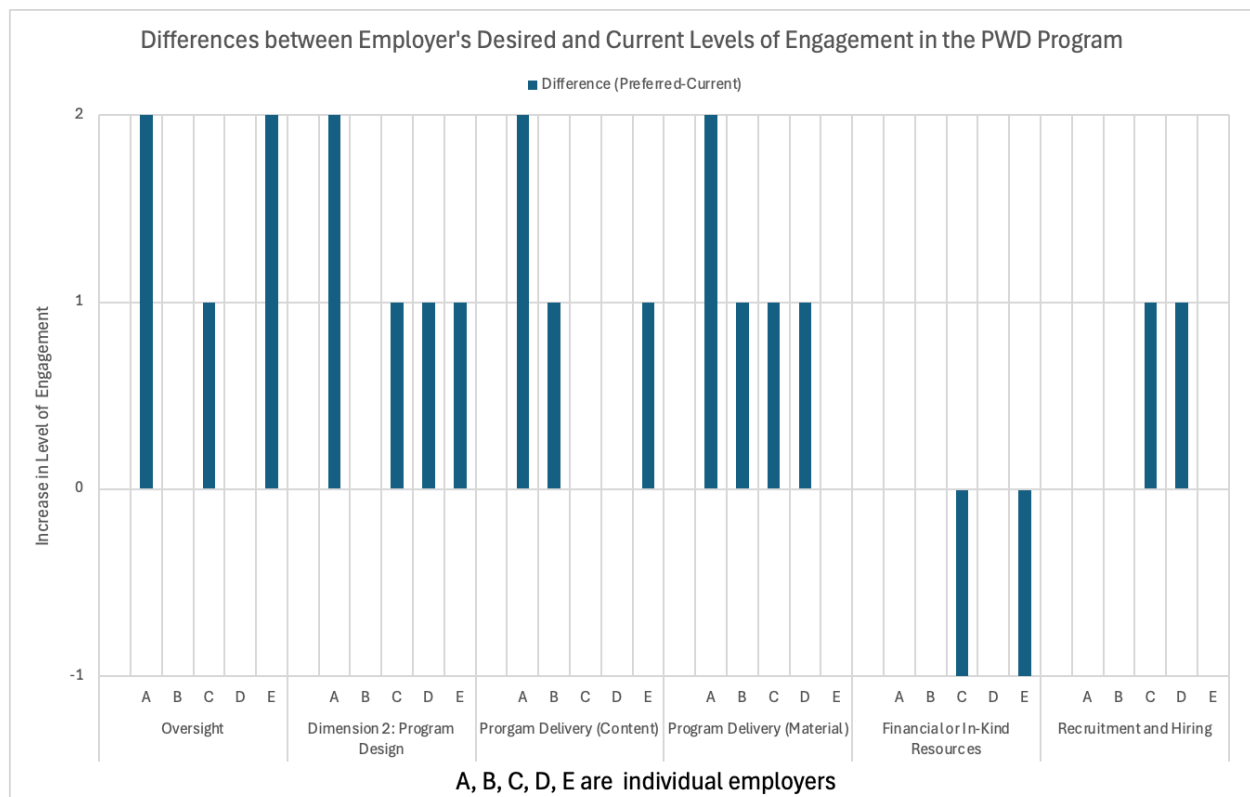


Figure 1. Differences between employers’ preferred and current levels of engagement in the PWD program across dimensions

A clear trend emerges: employers favor higher engagement levels in every area except providing financial or in-kind resources to employees. They show a strong desire to contribute more meaningfully in oversight, program design, and program delivery, whether through offering input, shaping curricula, or directly participating in training activities. However, no employer expressed interest in providing resources more frequently, and two even indicated that they would prefer to reduce resource provision during the program. The remaining three employers’ preferred and current engagement levels matched this dimension.

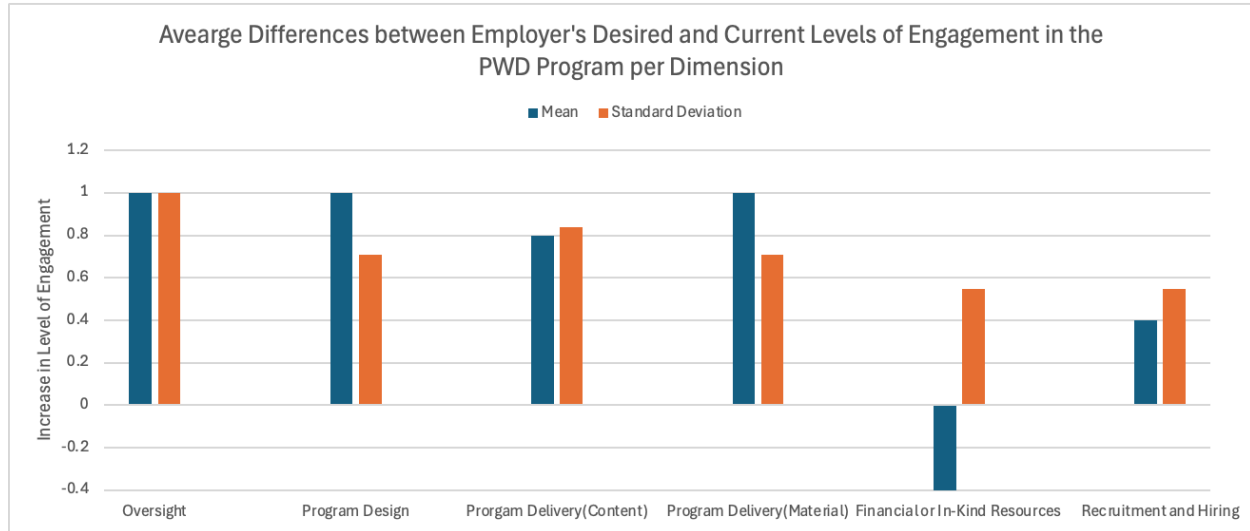


Figure 2. Average differences between employers' preferred and current levels of engagement in the PWD program per dimension.

The differences between employers' preferred and current levels of engagement in PWD programs vary across the dimensions. Figure 2 illustrates these average differences among all five manufacturers, revealing that employers strongly favor increased involvement in oversight, program design, and program delivery. In contrast, they show only a slight increase in program recruitment and even a decrease in providing employee resources. Paired T-tests confirm that the desired increases in program design ($p\text{-value} = 0.034$) and program delivery (material) are significant ($p = 0.034$).

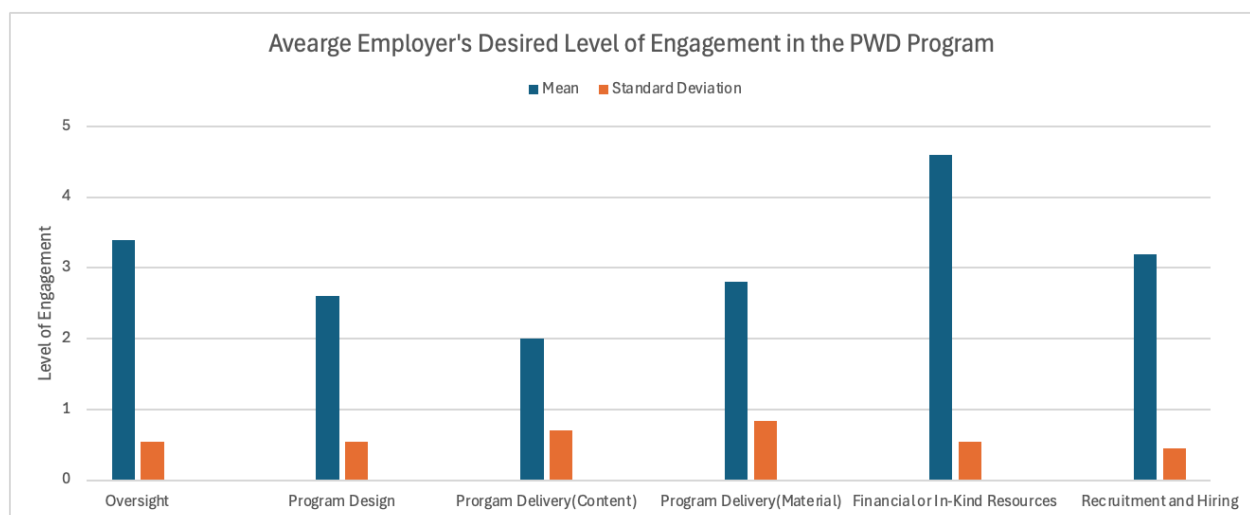


Figure 3. Average employers' preferred level of engagement in the PWD program across dimensions.

Additionally, employers indicated varying levels of desired engagement across the different dimensions of the PWD program, as illustrated in Figure 3. For instance, they typically prefer to offer input, suggestions, or teaching materials once every cohort but show a strong desire to constantly provide ongoing resources and support for employees. This variation underscores the nuanced ways employers want to engage, reflecting how each activity aligns with their workforce needs and organizational goals.

4.2. Employers' Preferred Tasks for Greater Engagement in PWD Programs

Manufacturers expressed specific tasks they would like to undertake to enhance their involvement in PWD programs. These tasks span multiple dimensions – oversight, program design, program delivery, recruitment and hiring, and financial/ in-kind resources – reflecting their desire to contribute more actively to the success of these initiatives:

4.2.1. Oversight

Employers expressed interest in serving on the program's advisory board to provide strategic guidance and share insights into industry trends, including emerging skills, tools, and technologies that should be incorporated into the program. Four participants currently serve on the advisory board, offering guidance and consulting for the PWD program. Participants also contributed ideas for skills and content needed in the industry: "Absolutely, you can ask Bob. I was the one who came to him with the idea of the lean consortium, and now I'm advocating for an HR consortium. I think human resources presents a great opportunity. We could band together as a group within the Berkshires, bringing together manufacturers and other companies. I believe [the PWD program] is great for manufacturing and engineering-based companies, but I also see potential for soft skill leadership programs that could be developed."

4.2.2. Program Design

Employers preferred opportunities to provide feedback and suggestions on curricula, timelines, and program structures to ensure alignment with industry needs. One participant mentioned making adjustments to the program: "I actually made some changes to include the content we wanted the program to cover. I made suggestions about what should be delivered."

Another participant emphasized the importance of timely feedback: "Probably within a month after the graduation ceremony, when we still have fresh perspectives on the cohort, companies should also have a few weeks to observe changes in behavior or approach by participants. Then, we can return to discuss what happened during the program and what could be improved for the next cohort."

Specific recommendations regarding program hours were also offered: “I think most employees would prefer attending during working hours rather than in the evening. Consider scheduling sessions in the morning or afternoon, maybe every third cohort. This could increase engagement and participation.”

4.2.3. Program Delivery

Employers proposed contributing teaching materials, such as case studies and project topics, to make training more practical and industry-relevant. “For participants, we can help decide what projects they should undertake.” Others expressed willingness to support through additional teaching materials and hands-on projects: “As a company, we can provide teaching materials or project opportunities. Participants could even visit our site to work on projects, even if they don’t work for us.”

Employers also want progress updates on participants. “Maybe halfway through the cohort, there could be a brief touchpoint with instructors and the company to discuss engagement and learning progress. This could help identify strengths and areas for improvement.”

4.2.4. Recruitment and Hiring

Employers actively promote the PWD program to employees to build a more skilled workforce. Participants shared proactive measures they’ve taken: “We often make announcements internally and hold employee socials to discuss the program.”

Some go further by identifying and encouraging individuals: “We’ve encouraged three or four employees to join the cohort and frequently bring it up in supervisor and manager meetings. Ideally, at every monthly supervisor meeting, we’d mention that another cohort starts in six weeks and encourage participation. It’s a great program that provides valuable information to help employees grow in their roles and advance within the organization.”

4.2.5. Financial or In-Kind Resources

Employers support employees’ participation by integrating program tasks into regular work hours. “We support sending employees to the program during work time.” Employers also provide mentoring and supervisory support: “We’ve met with participants weekly, offering guidance, opportunities, and insights to help them complete their projects successfully.”

Lastly, employers celebrate employees’ achievements to highlight the program’s value and inspire others to participate: “It’s been amazing to celebrate our employees and their accomplishments. We love attending graduation ceremonies and recognizing their hard work.”

These tasks highlight the multifaceted ways employers aim to engage in PWD programs, underscoring their commitment to creating a collaborative and supportive learning environment. By incorporating these contributions, PWD programs can enhance their relevance, effectiveness, and appeal to both employers and participants.

5. Discussion

The findings of this study reveal valuable insights into manufacturing employers' perspectives on their involvement in PWD programs. Employers expressed both a desire and willingness to increase their engagement in various aspects of these programs, with specific tasks and strategies for contributing effectively. This discussion explores the implications of these preferences and identifies actionable steps for enhancing employer involvement.

5.1. Interpreting Employers' Preferences for Engagement

Employers show a strong desire for deeper involvement across three of the five dimensions in Spaulding and Martin-Caughey's framework: oversight, program design, and program delivery. This desire points to a broader recognition of how collaborative efforts can enhance workforce development. These findings also align with existing literature that underscores the value of employer input for ensuring the relevance and effectiveness of workforce initiatives [6].

Their interest in oversight indicates that employers want a say in the strategic direction of PWD programs. Serving on advisory boards allows them to ensure alignment with both current and emerging industry needs. Likewise, their focus on program design and delivery highlights the importance of integrating real-world expertise into training approaches, bridging the gap between theoretical instruction and practical workforce demands.

Meanwhile, the shift from zero-increase to decrease in desired engagement seems to stem from an already high level of support in providing resources. All five employers currently offer weekly assistance to participants, a point illustrated by one employer's comment: "[We] didn't know what to do at the beginning [to help], so we just did it whenever they needed. But [we realize that] we don't have to do that often." This suggests employers recognize that providing intensive resource support may not be necessary at all times. Still, they indicate that among all engagement dimensions, offering employees resources remains the one they most frequently undertake.

Overall, these preferences reflect a dual emphasis on both operational and strategic engagement, indicating that employers value opportunities to shape program design while simultaneously delivering hands-on support to their employees.

5.2. Implications for PWD Program Design

The findings suggest several actionable steps for designing and implementing PWD programs that align with employers' preferences.

Structured Engagement Models: PWD programs should establish clear pathways for employer engagement across all dimensions. For example, creating tiered advisory roles or offering various levels of involvement in program design can accommodate diverse employer needs.

Enhanced Communication Channels: Creating platforms for regular dialogue between employers, educators, and training providers can facilitate a better understanding of needs and priorities. Collaborative planning sessions, workshops, and feedback mechanisms can help align expectations and foster stronger partnerships.

Flexible Program Setting: Offering employers support in integrating PWD program tasks into their operational workflows (e.g., allowing flexible program-hour options) can enhance employee enrollment and organizational buy-in.

These strategies not only address employers' expressed preferences but also position PWD programs as essential partners in workforce development.

5.3. Limitations

One limitation of this study is the potential bias introduced by the PWD program's influence on the participants. All the companies included in the research have at least one employee who graduated from the PWD program. The employers expressed high praise for such employees and the program during the interview. This scenario suggests the participants may be more committed and motivated to support and enhance the program compared to the average manufacturing firm.

Additionally, all interview participants are either members of the PWD program's advisory board or individuals who have previously engaged with the program. These participants have already established strong working relationships with the program's host agency and are actively involved in industry-education collaboration and workforce development efforts. This level of engagement may have influenced their responses, potentially amplifying their expressed preferences and willingness to contribute to the design and implementation of the PWD program.

While these factors provide valuable insights from highly engaged stakeholders, they may not fully represent the perspectives of less-involved employers or those with limited experience in collaborative workforce development initiatives. Future research should seek to include a broader range of participants to capture a more diverse and representative understanding of employer engagement in PWD programs.

Overall, employers' willingness to engage more deeply in PWD programs underscores the potential for stronger partnerships between industry stakeholders and workforce development initiatives. By addressing employers' preferences and providing structured opportunities for involvement, PWD programs can foster collaboration that benefits all stakeholders. The findings emphasize the need for a holistic, flexible approach to employer engagement that aligns program objectives with industry needs, ultimately contributing to a more skilled and competitive workforce.

6. Future Work

The next phase of this research focuses on understanding employers' perspectives on productive engagement with specific aspects of PWD programs. This includes exploring their desired roles in the design and implementation of the learning environment within PWD initiatives. Gaining these insights is critical for tailoring programs that align with both industry needs and stakeholder expectations.

The research will inform the development of a conceptual framework, referred to as the Combination-of-Perspectives for Professional Development (COOP-PD) model. This model is intended to guide the practice of engaging diverse stakeholders, including employers, in the collaborative design and implementation of learning environments within PWD programs. The COOP-PD Model will aim to: define employer roles, promote multi-stakeholder collaboration, enhance program relevance, and support scalability.

This study also highlights the need for further research into scalable methodologies for employer engagement in PWD programs. Specifically, future work should explore: 1) The effectiveness of specific engagement strategies in enhancing program outcomes. 2) The barriers employers face in increasing their involvement and how these can be mitigated. 3) The impact of sustained employer engagement on workforce readiness and organizational performance.

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References

- [1] “Advanced Manufacturing: A New Narrative,” World Economic Forum, Sep. 15, 2023.
<https://www.weforum.org/publications/advanced-manufacturing-a-new-narrative/>
- [2] E. Brynjolfsson and A. McAfee, *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*, W W Norton & Co, 2014.
<https://psycnet.apa.org/record/2014-07087-000>
- [3] “2024 Second Quarter Manufacturers’ Outlook Survey,” NAM, Jul. 18, 2024.
<https://nam.org/2024-second-quarter-manufacturers-outlook-survey/>
- [4] J. Bessen, “Learning by Doing: The Real Connection between Innovation, Wages, and Wealth”. 2015. Yale University Press. Available: <https://scholarship.law.bu.edu/books/342>.
- [5] M. Valiente Bermejo, M. Eynian, L. Malmsköld, and A. Scotti, “University–industry collaboration in curriculum design and delivery: A model and its application in manufacturing engineering courses,” *Industry and Higher Education*, p. 095042222110642, Dec. 2021, doi: <https://doi.org/10.1177/09504222211064204>.
- [6] S. Spaulding and A. Martin-Caughey, “The Goals and Dimensions of Employer Engagement in Workforce Development Programs,” *Employer Engagement in Workforce Development Program* 2015. Available:
<https://www.urban.org/sites/default/files/publication/76286/2000552-the-goals-and-dimensions-of-employer-engagement-in-workforce-development-programs.pdf>
- [7] K.S. Campbell, “Manufacturing Workforce Development Playbook Manufacturing Workforce Development Playbook Preparing for the Manufacturing Renaissance in America,” Summit Media Group, Inc, 2014. Available:
https://www.nist.gov/system/files/documents/2017/04/28/Manufacturing_Workforce_Dev_Playbook.pdf
- [8] L. Li, “Reskilling and Upskilling the future-ready Workforce for Industry 4.0 and beyond,” *Information Systems Frontiers*, vol. 24, no. 3, pp. 1–16, Jul. 2022, doi: <https://doi.org/10.1007/s10796-022-10308-y>.
- [9] R. Maclean, S. Jagannathan, and B. Panth, “Education and Skills for Inclusive Growth, Green Jobs and the Greening of Economies in Asia: Case Study Summaries of India, Indonesia, Sri Lanka and VietNam,” *Technical and Vocational Education and Training: Issues, Concerns and Prospects*, vol. 27, Springer, 2018.

- [10] S. Billett, "Integrating learning experiences across tertiary education and work settings: A conceptual proposal," *Educational Research Review*, vol. 12, pp. 1–13, 2014.
- [11] P. Brown, H. Lauder, and D. Ashton, *The Global Auction: The Broken Promises of Education, Jobs, and Incomes*. Oxford University Press, 2011.
- [12] J. Moon, *Corporate Social Responsibility: A Very Short Introduction*. Oxford University Press, 2014.
- [13] R. Dodge, J. Dwyer, and S. Witzeman, "Driving corporate innovation: Design for sustainable growth," *Research-Technology Management*, vol. 60, no. 2, pp. 22–30, 2017.
- [14] S. Billett, *Learning Through Practice: Models, Traditions, Orientations, and Approaches*. Springer, 2011.
- [15] M. Eraut, "Informal learning in the workplace," *Studies in Continuing Education*, vol. 26, no. 2, pp. 247–273, 2004.
- [16] V. J. Marsick and K. E. Watkins, "Demonstrating the value of an organization's learning culture: The dimensions of the learning organization questionnaire," *Advances in Developing Human Resources*, vol. 5, no. 2, pp. 132–151, 2003.
- [17] OECD, "Employees by business size," [Online]. Available: [https://www.oecd.org/en/data/indicators/employees-by-business-size.html#:~:text=For%20this%20indicator%2C%20enterprises%20are,persons%20employed%20\(large%20enterprises\)](https://www.oecd.org/en/data/indicators/employees-by-business-size.html#:~:text=For%20this%20indicator%2C%20enterprises%20are,persons%20employed%20(large%20enterprises).). [Accessed: Jan. 24, 2025].