IDENTIFYING THE INDUSTRIAL SKILL GAP AND ADVANCING INDIVIDUAL LEARNING METHODOLOGIES

by

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STATEMENT OF COMMITTEE APPROVAL

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DEDICATION

The following research report and analysis are sincerely dedicated to my late mother, Ann Sarah Bannister. Words cannot describe how your words of encouragement over the years instilled positivity and steadfast determination. I miss your presence, but your spirit lives on in my heart, thank you.

ACKNOWLEDGMENTS

I would like to take this moment to express my gratefulness to all faculty involved within the Purdue University Graduate School. Professor John H. Dickey's instruction has been monumental in guiding my path within the program. I am very grateful to have studied and learned under great leadership. I am extremely fortunate to have experienced a great educational journey from a prestigious school, called Purdue University.

To my wife, Vanessa Pitts Bannister, who does not recognize the word, quit. I would not have completed the Master's Degree program without your unwavering sacrifice over the last two years. Your support and understanding will always be appreciated and never forgotten. Thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BLS	Bureau of Labor and Statistics
CDRP	Capstone Directed Research Project
CNC	Computer Numerical Control
DOL	Department of Labor
GDP	Gross Domestic Product
GED	General Educational Development
HCMS	Human Capital Management System
L&D	Learning and Development
NAM	National Association of Manufacturers
NCS	National Compensation Purposes
OEE	Overall Equipment Effectiveness
OEM	Original Equipment Manufacturer
OJT	On-The-Job Training
ROI	Return on Investment
SHRM	Society of Human Resources Management
SIC	Standard Industrial Classification Codes
TFP	Total Factor Productivity

GLOSSARY

Analysis of Variance (ANOVA)	Statistical method used for hypothesis testing (Purdue University Libraries, n.d.).
Apprenticeships	A learning methodology that is shown to be a promising pathway for filling many skilled jobs that are left unfilled in the manufacturing industry (Deloitte, 2018c, p. 15).
Bureau of Labor Statistics (BLS)	An organization that provides data and statistics, specific to demographics, industry, business, occupation, and geography (Purdue University Libraries, n.d.).
Competency Mapping	Comprehensive list of competencies which a star performer possesses, along with their level of possession (Christina, 2016, p. 8).
Computer Numerical Control	Computer controlled machines that utilize coded programs for fabrication, cutting, and shaping various metals (Purdue University Libraries, n.d.).
Continuous Learning Model	The basis for any learning involves the employee, motivation, andassets, within the manufacturing industry (Deloitte, 2016).
Cytarabine	A human genetic pharmaceutical drug used to treat leukemia patients (Sills, 2011).
D&B Hoovers	Database used to gather business data, company and private profiles, executivedata, and industry research (Purdue University Libraries, n.d.).
Deloitte	A consulting firm that surveys and performs studies on a wide range of industriespertaining to personnel, groups, and industries (Purdue University Libraries, n.d.).
Department of Labor (DOL)	A listing of professional and related occupations that contains statistics and employment projections (Purdue University Libraries, n.d.).
Dynamic Matching Lifecycle Model	Analysis of workers that are heterogenous or flexible within their skillsets that further enhances the need for human capital (Purdue University Libraries, n.d.).

General Educational Development	Educational credential given to school dropouts in the United States (Purdue University Libraries, n.d.).
Generation-X	The part of society born between 1965 and 1979 (Purdue University Libraries, n.d.).
Gross Domestic Product (GDP)	A comprehensive and unique measure of the total final output ofall goods and services produced within an economy whether for sale or own use (Purdue University Libraries, n.d.).
Human Capital	The idea that expertise, instruction, design, ability, and people's well-being, arepart of a particular economic foundation (Becker, 2002).
Human Capital Management System (HCMS)	Specific systems needed for a smooth integration towards sustaining human capital (Hughes, 2019, p. 4).
Learning and Development (L&D)	Internal-Knowledge sharing programs, portals, video sharing systems, collaborative experiences, that help people constantly learn and share knowledge (Deloitte, 2016, p. 58).
Likert Scale	A series of responses numbered from one to five (1-5), that's used to measurecharacter and personality traits (Purdue University Libraries, n.d.).
Mann-Whitney U Test	Statistical test that is used to determine if there are statistically significant differences between two groups (Purdue University Libraries, n.d.).
Manufacturing Institute	A firm that represents the industry's skilled workforce towards thepromotion within current manufacturing (Purdue University Libraries, n.d.).
Mergent Online	U.S. financial database firm used for the purposes of collecting information ondomestic and international companies (Purdue University Libraries, n.d.).
Methodology	The research strategy or method that a person uses to conduct research, or collectsdata (Purdue University Libraries, n.d.).
Millennials	The part of society born between 1980 and 2000 (Purdue University Libraries, n.d.)

National Academy of Engineering Grand Challenges	Identified in 2008 by a committee, a host of global challenges that must be addressed through long-term and innovative education, research, and engineering solutions (Purdue University Libraries, n.d.).
National Association of Manufacturers (NAM)	An industrial trade organization founded in 1895,for the purposes of defending business against the uproar of criticism (Purdue University Libraries, n.d.).
National Compensation Survey (NCS)	A survey conducted by the Bureau of Labor and Statistics that is used to examine the skill content of low-wage jobs (Purdue University Libraries, n.d.).
On-The-Job Training (OJT)	Work-based learning, trial by error learning, or observation and demonstrated learning and behaviors of others (Purdue University Libraries, n.d.).
Original Equipment Manufacturer (OEM)	An alignment of component parts bought from other manufacturers or organizations (Purdue University Libraries, n.d.).
Overall Equipment Effectiveness (OEE)	Factors that lead to increased downtime, increased cycle time, and increased overtime (Manufacturing Institute, 2014).
Qualitative Analysis	Knowledge production that involves the separation of elements of data according to some priori or data-derived system (Purdue University Libraries, n.d.).
Quantitative Analysis	Statistical and mathematical modeling, research, measuring techniques, tobetter understand behavior (Purdue University Libraries, n.d.).
Return-On-Investment (ROI)	Investing in people for the purpose of gaining specific skills thatyield a payback or return (Purdue University Libraries, n.d.).
S&P Capital IQ	A financial information platform that was originally designed to address theneeds of the investment banking community (Purdue University Libraries, n.d.).
Skilled Worker	Described as an artisan worker who is highly skilled, possesses a wide range ofskills and exercises some control over the admission of workers into the trade (Hagan, 1977, p.29).

Skills Gap	The current level of skill versus the level of skills actually exhibited (PurdueUniversity Libraries, n.d.).
Skills Shortage	The absence of skilled workers within the manufacturing sector (Cerasis, 2014).
Society of Human Resources Management (SHRM)	A survey firm that focuses on workplaceethics within a professional setting (Purdue University Libraries, n.d.).
Soft Skills	Nontechnical and not reliant on abstract reasoning, involving interpersonal andintrapersonal abilities to facilitate mastered performance in particular contexts (Purdue University Libraries, n.d.).
Standard Industrial Classification Codes (SIC)	Resource database used for the collection ofmanufacturing data correlated with the economy (Purdue University Libraries, n.d.).
The 2X2 Matrix	Universal framework developed to identify a particular deficiency, or lackthereof, for creating a matrix for skills improvement and creation (Lowly & Hood, 2004).
Tier-1	Supply chain consisting of companies that supply parts and systems directly to theOriginal Equipment Manufacturer or OEMs (Purdue University Libraries, n.d.).
Tier-2	Similar to Tier-1 in that the difference is Tier-2 supplies parts to Tier-1, then suppliesparts to an OEM (Purdue University Libraries, n.d.).
Total Factor Productivity (TFP)	The use of technology having a positive and significant relationship both with the ratio of skilled to unskilled labour, skilled-to-unskilled wage ratio, anda negative relationship between the degree of substitution between skilled and unskilled labour inputs are poor substitutes (Malik & Sousa, 2017, p. 128).
t-test	An inferential statistical method used for determining differences between two means ofgroups (Purdue University Libraries, n.d.).
Unskilled Worker	Described as a segment of the workforce associated with a limited skill set orminimal economic value for the work performed (Kagan, 2020).

U. S. Workforce Development System	Components that support the needs for initiating, sustaining, organizing, learning, and training of the workforce (McKinsey & Company, 2017).

ABSTRACT

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Nationally, manufacturing jobs are left unfilled (Queen, 2018). The economy suffers due to this deficit (Giffi, Dollar & Gangula, 2015). Research indicates that this deficit is due to the “skills gap” (Deloitte, 2018a, 2018b, 2018c). The intent of this research project was to determine the extent to which skills are correlated to performance, standards, and conditions. The project's methodology included research elements with a sample population (N) of ten metal manufacturing companies. Utilizing multiple quantitative and qualitative analyses, seven data points (n) of skilled and unskilled workers were analyzed. Research findings indicated statistical significance between skilled and unskilled workers in the areas of analysis. Particularly, unskilled workers tended to have lower scores than the skilled workers, and mean scores across the seven data points also revealed that the satisfactory skill level across the seven data points was unattainable. Research findings also indicated that a sizeable percentage of companies that did not offer training specific tothe seven data points emphasized the lack of investments in developmental training programs. Moreover, failure to acknowledge data points within quality policies or metrics across companiesintensified investment deficiency in human capital among corporations. The analysis results championed investing in training and investments in human capital. For the above reasons, it is paramount that companies invest in operator training initiatives; hence, promotion of more robust company obligations towards learning, and the advancement of the National Academy of Engineering Grand Challenges initiatives.

CHAPTER 1. INTRODUCTION

1.1 The Problem

Nationally, manufacturing jobs are left unfilled. Particularly, six out of 10 manufacturing jobs are left unfilled due to the lack of investment in developmental skilled learning and training programs within the United States (Queen, 2018). A recent study by Deloitte and the Manufacturing Institute (2016) found that manufacturers need to fill 4.6 million jobs from 2018-2028. As indicated in Figure 1.1, of the projected 4.6 million manufacturing jobs, only 2.2 million are likely to be filled. Deloitte and the Manufacturing Institute attribute the shortfall to the restricted skills within the manufacturing workforce. The effects of the manufacturing workforce deficit are substantive.

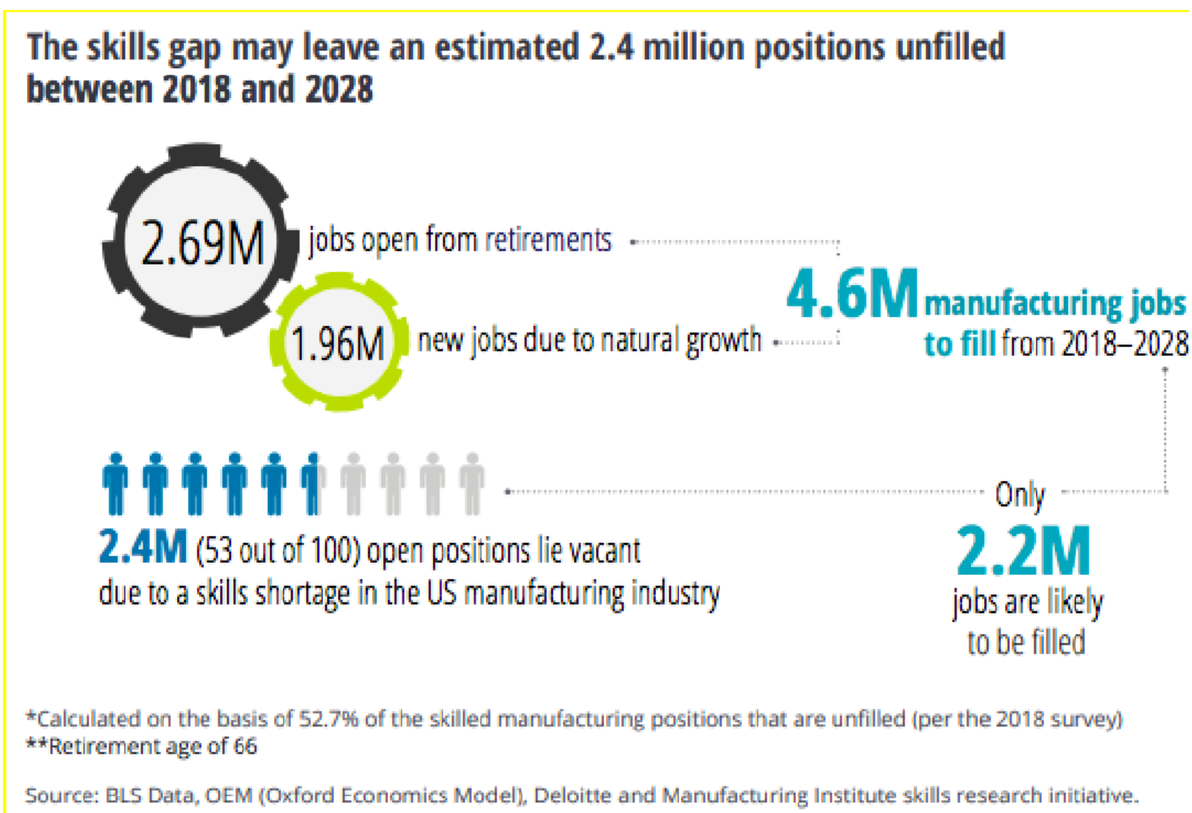

Figure 1.1: The Skills Gap (Deloitte, 2018a)

1.2 The Impact

The U.S. unskilled labor force deficit has led to significant labor adjustment costs across manufacturing industries within U.S. public firms. "Every job in manufacturing creates two and a half new jobs in local goods and services, and for every dollar invested in manufacturing, another $1.32 in additional value is created in other sectors" (Giffi, Dollar and Gangula, 2015, "para. five"). As indicated in Figure 1.2., Deloitte and the Manufacturing Institute (2018a) project that the skilled labor force deficit can lead to a major shortfall of 454 billion dollars in the manufacturing Gross Domestic Product (GDP). The shortfall will be up to 454 billion dollars if the manufacturing industry cannot address the deficit in skilled labor.

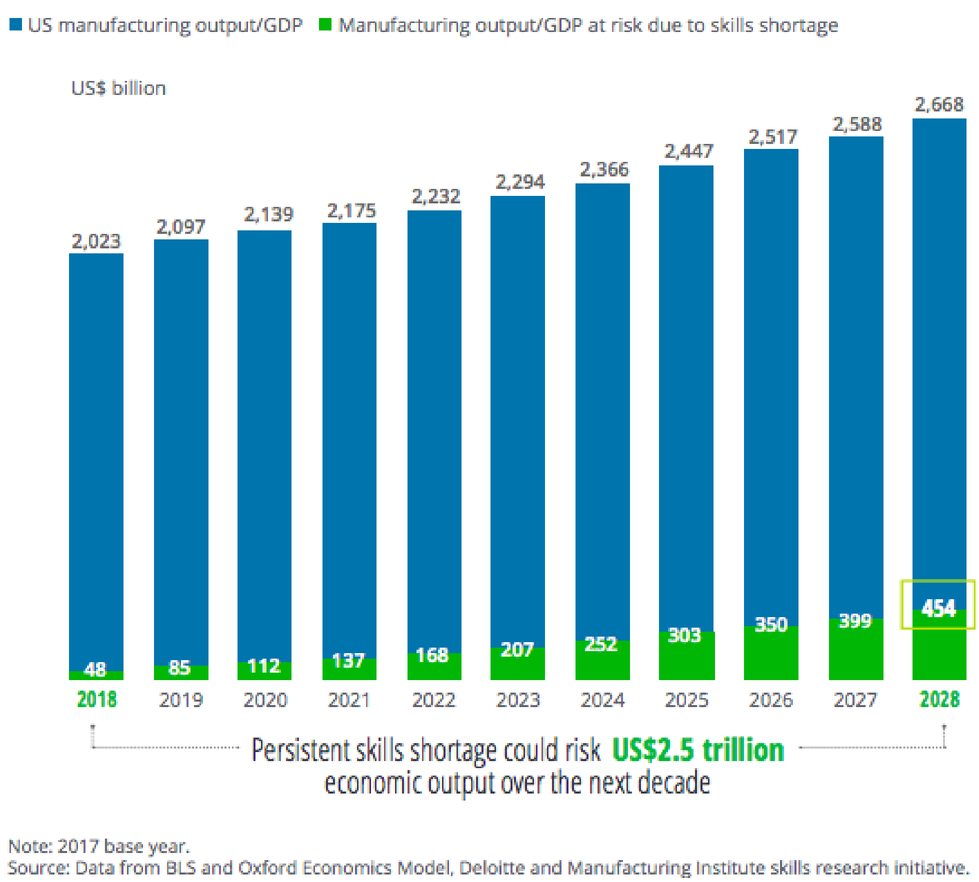

Figure 1.2: The Skills Shortage (Deloitte, 2018a)

The shortfall of the manufacturing labor force is consequential to other business sectors and human existence. For example, Sills (2011) indicates the impact on cancer patient therapies. Sills (2011) further describes how notable the leukemia pharmaceuticals industry issues are below:

> "The scarcity of not only cytarabine, but also numerous other drugs, is an urgent public health problem that both the drug industry and the government have an obligation to address. To do this successfully, both the causes and the solutions of this issue need to be understood in their broader context: the neglect of manufacturing, especially high-tech manufacturing, in the United States" (p. 156).

Moreover, the shortage of skilled labor also connects to declines in productivity within manufacturing. The correlation among various other circumstances, including increased crime rates, unemployment and underemployment, the percentage of the population below the poverty level, and decreased per capita income (White, 1999).

1.3 Measurement of the Problem

Various sources outline the impacts of skilled labor deficits (Deloitte, 2018a, 2018b; The Society of Human Resources Management, 2019). For instance, Infographics provides the following depiction outlining the influences of skill shortages on overall earnings. As indicated in Figure 1.3 on page 4, increased downtime, increased cycle time, and increased overtime costs lead to a decreased Overall Equipment Effectiveness (OEE) and increased annual overtime costs (Manufacturing Institute, 2014).

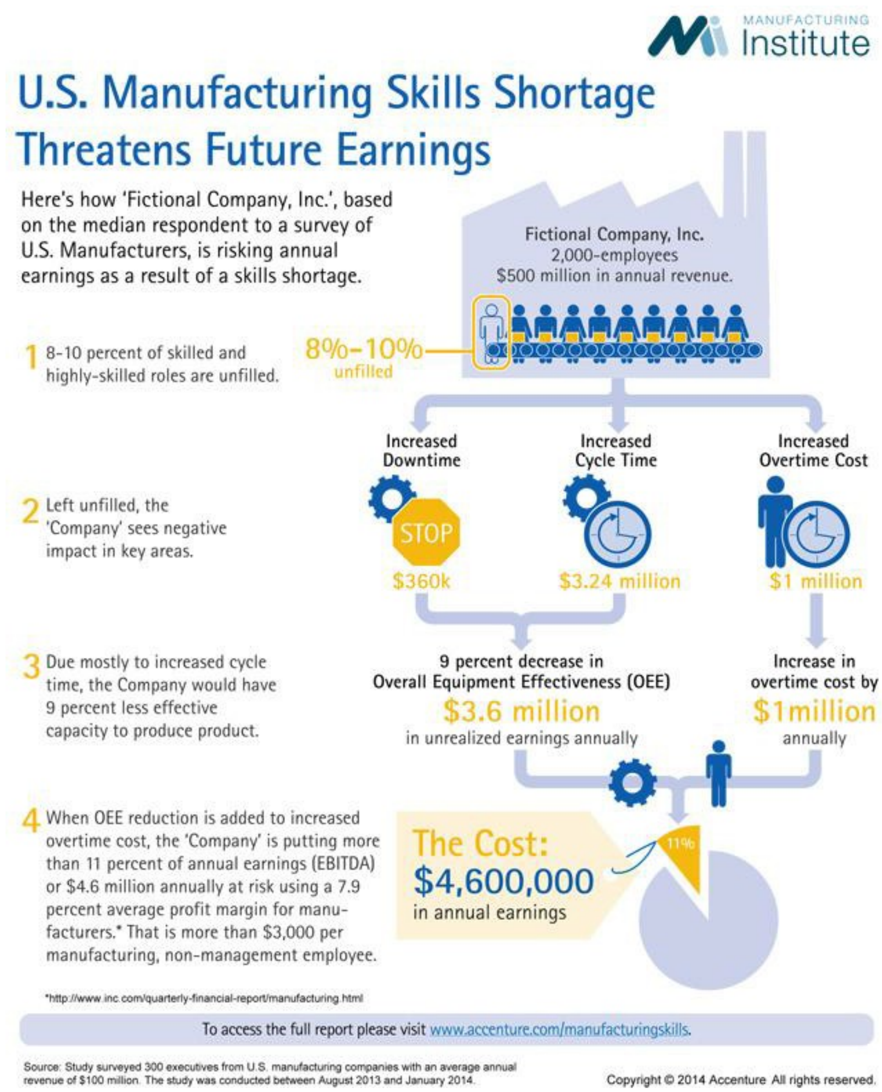

Figure 1.3: Skills Shortage Influences (Cerasis, 2014)

Such consequences emphasize the effect of not having skilled workers but do not adequately explain the correlation of skills to performance, standards, and conditions. Moreover, the emphasis is to quantify and understand the effects in light of performance, standards, and conditions. By comparing trained versus untrained employees' research results and the impact on quality, productivity, and safety, the problem will be measured. Particularly, the investigative method includes the analysis of a select corpus of research results. The investigation's foci include quantification and analysis of the skilled labor force deficit on performance, standards, and conditions.

1.4 National Academy of Engineering Grand Challenge Alignment

Extant literature emphasizes the impetus for technologically-inclined manufacturing workers (Saltanovitz, 2014; Smith, 2015). The aforementioned thrust elevates concerns for the diminishing manufacturing skilled workforce. Mallick and Sousa (2017) accentuates the dilemma below:

> "...technology has a positive and significant relationship both with the ratio of skilled to unskilled labour and with the skilled-to-unskilled wage ratio. In addition, we find a negative relationship between the degree of substitution between skilled and unskilled labour and TFP [Total Factor Productivity]. In particular, when the two labour in- puts are poor substitutes, differences in productivity are extremely large. Such differences have indeed increased over recent decades and can be linked with the fall in the elasticity of substitution between skilled and unskilled labour" (p. 128).

The problem of a diminished skilled workforce was analyzed in two ways. The first analysis entails juxtaposing research results regarding skilled and unskilled workers and the effects on performance, standards, and conditions. The second analysis involves juxtaposing components of a learning methodology, particularly apprenticeship programs, for manufacturing programs and results from the first juxtaposition. Focusing on the extent of the alignment between the learning methodologies and identified "skills gap" is to "shape the sources and directions of innovative activities" (Mallick & Sousa, 2017, p. 129) that aim to improve the manufacturing workforce.

Promoting advanced learning methodologies for manufacturing programs will be linked to the National Academy of Engineering Grand Challenge of AdvancedPersonalized Learning (Zwers, 2010).

1.5 Summary of the Problem Statement

The urgent need to advocate for investments in manufacturing programs within the United States has lingered extensively. The prolongation of inactions and lack thereof will continue to leave a rippling effect throughout the manufacturing and other associated industries. Stagnation after-effects cause the influx of labor inconsistencies between skilled and unskilled workers, requiring ananalysis of objectives and solutions. Gaining a true understanding of requirements to identify and shore up the skills deficiencies (i.e., "skills gap") will necessitate using learning methodologies suitable for personalized learning advances. One learning methodology, apprenticeships, has shown to be a "promising pathway for filling many of the skilled jobs that lie open in the manufacturing industry" (Deloitte, 2018c, p. 15). Insight from the United States Department of Labor (2020) recently announced 100 million dollars of grants for apprenticeship programs. The Department of Labor and various organizations (e.g., The Society of Human Resources Management, Deloitte, Manufacturing Institute) aim to shed light on productive ways to minimize the "skill gaps." Similarly,

> "instead of fretting about a skills gap, we [as a Nation] should be focused on the real challenge of knitting together the supply and demand sides of the labor market. Thinking about the real financial and institutional mechanisms necessary to make, say, apprenticeships work is far more productive than perennially sounding alarms about under-skilled workers" (Weaver, "para. 16").

CHAPTER 2. REVIEW OF LITERATURE

The United States of America is generally perceived as the “land of opportunity” (McKinsey and Company, 2019). To fulfill the perception of opportunity, processes must occur to develop qualified candidates. Figure 2.1 below illustrates six reasons organizations struggle to hire suitable candidates. Three of the six identified struggles relate to the competency of the applicants. Due to such factors, over one-third of the organizations surveyed indicate a decrease in applicant quality across various areas of expertise (The Society of Human Resources Management, 2019). Particularly, work experience, technical skills, and workplace (soft) skills are relevant to applicants' knowledge base. Whether or not applicants have the knowledge base details the dilemma of skilled vs. unskilled workers.

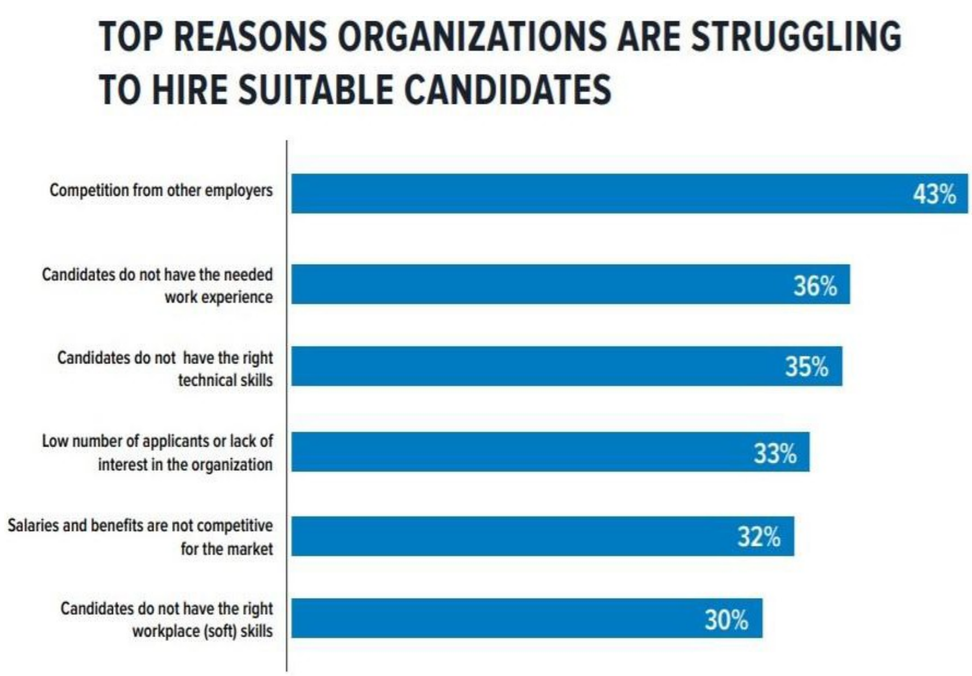

Figure 2.1: Top Reasons Organizations Are Struggling to Hire Suitable Candidates(The Society of Human Resources Management, 2019)

2.1 Interpretations of Skilled and Unskilled Worker

Nationally, various factors determine the classification of workers (U.S. Bureau of Labor Statistics, 2001). For the research project's purpose, the terms skilled worker and unskilled worker will reflect characteristics identified within the section. The below discussion includes brief explorations of the terminologies of *skilled worker* and *unskilled worker*.

Researchers suggest that the commitment to skilled workers is paramount to productivity in the workplace. For instance, Gabszewicz and Turrini (2000) brilliantly articulate the association between skills and productivity in the following excerpt:

> "In a market economy, the supply of skills is determined by private incentives originating on the labour market. The demand for skilled labour, in turn, depends on firms' incentives on the product market. If firms find it to be convenient to sell low-quality (high-quality) products, their demand for skilled labour is low (high), and market wages for qualified workers do not (do) stimulate an abundant supply of skills" (p. 576).

As Gavszewicz and Turrini (2000) suggested, the classification of workers reflects corporations' quality choices. Such quality choices are grounded in the effects of skilled workers and unskilled workers. The concept of a *skilled worker* (or skilled labour) is an interesting terminology. The terminology has evolved. For instance, Hanagan (1977) analyzes the concept via Marx's Capital. According to Hanagan (1977), Marx's Capital describes an artisan worker as "one who was highly skilled, possessed a wide range of skills, and exercised some control over the admission of workers into his trade" (p. 29). The following depiction, Hanagan (1977) characterizes skill as a "scarce ability which it takes time and effort to acquire" (p. 29). Hanagan (1977) further indicates the extensive and complex nature of this definition in the following example:

> "The definition of skill is a broad one which includes the manual dexterity of the wood

> joiner and the shoe laster as well as the extraordinary physical capacity of the forger. In any case, it is frequently difficult to evaluate the relative share of dexterity and capacity in determining skill" (p. 29).

The above definition emphasizes an individual's skill set. Particularly, the definitionsuggests that a skilled worker can perform satisfactory performance within his or her chosen occupation.

Similar to Hanagan's (1977) findings, Minneci (2015) posits the complex definitive nature of a skilled worker in the following excerpt.

> "Despite a growing interest in the phenomenon, particularly since the 1990s, the international scientific community has not provided a universally accepted definition of highly skilled workers so far, because of differences between countries in terms of education systems and recognition of qualifications" (p. 171).

Minneci (2015) further asserts that extant literature "focus[es] on the level of education of the highly skilled worker, others on the type of occupation in the country of destination and others on combination of both" (p. 171).

The concept of a *skilled worker* has different meanings determined by factors associated within a specific occupation. Machine operators required only a limited amount of knowledge and skills to be proficient. Moving forward, the advances in technologies present the need to recruit and train personnel for more advanced job skills and opportunities. Due to the shortfall of required training initiatives and inadequate skill development programs, skilled worker conditions within manufacturing will remain unfavorable. For instance, six out of 10 manufacturing jobs are left unfilled due to the lack of investment in developmental skilled learning and training programs within the United States (Queen, 2018). The concept of an unskilled worker is a person within an industry that has little to no job knowledge. For instance, Kagan (2020) provides the following definition of unskilled workers: “a segment of the workforce associated with a limited skill set or minimal economic value for the work performed. Unskilled labor is generally characterized by a lower educational attainment, such as a high school diploma, GED, or lack thereof, and typically results in smaller wages. Work that requires no specific education level or specialized experience is often available to the unskilled labor force” (“para.1”).

Similarly, The US Bureau of Labor Statistics defines an unskilled worker as follows: “For National Compensation Purposes (NCS), laborers are unskilled workers [individuals] who perform tasks at the work area. Laborers perform unskilled tasks, primarily manual, and do not have an area of trade specialization” (U.S. Bureau of Labor Statistics, 2001, “para.16”).

Skilled and unskilled workers’ definitions draw attention to the stark differences betweenthe two categories of workers. Particularly, the classification of a laborer is similar to the classification of the unskilled worker. Moreover, the skilled worker is matched to an apprentice's classification because of the skills gained while working in the industry. The designation of the skilled and unskilled worker titles projects the notation that specificity is just as important as the actual description of both workers.

2.2 The “Skills Gap”

The ever-changing landscape of employer requirements and worker skills alters the norms for obtaining adequate skills. The methods for obtaining skills within the industry and learning institutions do not favor the unskilled employee due to advances in technologies. Such "advances within the industry have developed a void in terms of workers' skills and employer expectations" (Apprenticeship.gov, 2020). The "Skills Gap" is a common problem for corporations. Due to the "Skills Gap," Deloitte (2018a) indicates that the time to fill a position from 2015 to 2018 has increased by at least 25%. As indicated in Figure 2.2, the percentage increases between 70 to 93 for skilled production workers, 94 to 118 for Engineers, Researchers, and Scientists, and 48 to 90 for all other workforce areas are 32%, 25%, and 87.5% respectively.

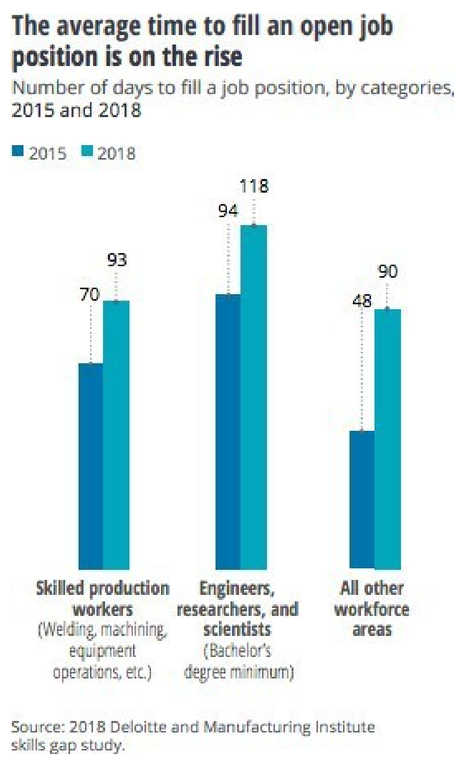

Figure 2.2: The Dilemma of Filling Open Jobs (Deloitte, 2018a)

The relevant skills that were once suitable or capable are now changing due to certain factors. Deloitte (2018b) proposes that the key skills needed to succeed in the manufacturing sector include digital skills, technology, and computer skills, programming skills for robots and automation, critical thinking, and using tools and techniques. Investing in the right skills is the best possible scenario for preparation for the future (Deloitte, 2018b).

2.2.1 Addressing the "Skills Gap" via Apprenticeship Programs

Placing more emphasis on apprenticeship programs decreases the skills gap. If employer-sponsored apprenticeship programs are readily available, advanced quality, and adequately promoted, the pathways towards a skills gap solution will be promising (Apprenticeship.gov, n.d.). Apprenticeship.gov (n.d.) suggests that specialized training provides opportunities for unskilled workers to learn industry-specific skills. Additional trade-specific course study followed by on-the-job training is key to conform to industry needs.

The urgency for adapting more advanced manufacturing technologies needs to be complemented by improved methods for skilled learning concepts. Apprenticeship.Gov (n.d.) states that additional emphasis ought to focus on what skills workers require and how teachers are using their techniques to access and develop better learning methods for decreasing skills deficiencies.

Apprenticeships provide one important component towards the quest for closing the skills gap. The journey starts at the early stages of an industrial worker's career ambitions. As technologies and manufacturing processes continue to get more and more advanced, the American worker's skills continue to trend towards a downward trajectory. The approach to remedy the skills gap's undesired effects is a task that will include a wide range of contributing factors. Considering the factors critical industry requirements, advanced manufacturing, and increased technical aptitude, the skilled worker has little to sustain the status quo.

Apprenticeship.gov continues to overstress the need for supporting apprenticeship programs through critical support personnel. Until there is a linked partnership between industry leaders and educational institutions, the skilled worker will become irrelevant due to the numerous technological advances within manufacturing (Apprenticeship.gov, n.d.). The industry is moving quickly towards the next industrial revolution, which includes advanced manufacturing and automation. To prepare the industry workforce for the next advancement, industry leaders must implement the necessary changes simultaneously and expeditiously. There is great concern that the skills gap is not being addressed properly, and skilled workers' developments continue to falter. A recent survey by the National Association of Manufacturers indicates that 90 percent of manufacturers express optimism about the future and about 75 percent express deep concerns about their ability to attract and retain a quality workforce moving forward" (National Association of Manufacturers).

2.3 Defining Human Capital

Corporations are in positions to define what connotes a skilled worker. Such indications are linkedto human capital. The manner in which human capital is defined varies. For instance, Woodall (1987) suggests that human capital is defined by people investing in themselves through education,training, and additional activities. Also, the investment payoff is rewarded through higher earnings during the person's career. Woodall (1987) further mentions the importance of investments and the requirements necessary for achieving the goals to serve the people and a person's wages throughout their careers. Woodall (1987) also conceptualizes other important attributes about whathuman capital means and who it benefits. Woodall further highlights the following four main subjects and details that are required for a more in-depth understanding of human capital:

1. The analysis on the amount of return to funding in human capital,

2. Profitability of human capital versus physical capital,

3. How is human capital linked to the worker’s efficiencies, and

4. The additional types of investments towards human capital.

Becker (2002) offers a varied perspective of human capital. Becker’s conception of human capital highlights expertise, instruction, design, ability, and people's well-being within a particular economy. Gary Becker is best known for the many viewpoints that human capital provides, both personally and on a corporate level. Becker stresses the most significant component of human capital is the investments in people – the driving force behind human capital. Depending on the type of business (economy) and its respective sector, the driver behind the human capital is linked to a specific attribute. Moreover, human capital is either tangible, virtual, personal, innovative, or economical. The undisputed claim for settling on a concrete hypothesis is that human capital on a personal contribution level is the model of choice.

Keeley (2007) introduces human capital as competence, skills, understanding and traits, that advance individual and societal benefits, contributing to a person’s respective country. Keeley's main idea of human capital is about a person's competencies and potential advancements. Once competencies develop, a specific component will allow the person to make a societal contribution or benefit the person’s home country. Considering there are many pathways and initiatives suggesting the basic competencies of human capital, there is broader alignment for a deeper understanding of people and skills. The elements of childhood serve as contributing factors for developing human capital.

Commonalities and differences exist between the varied notions of human capital. The notions highlight what human capital is, the components, the benefits, and the recipients. The main commonality is the investment in people and their drive towards obtaining specific skills. The backbone of human capital is investing in the person; the payback serves as the Return On Investment (ROI) for both parties involved. One big difference includes the defining feature of societal benefits as an area of focus. No one definition of human capital will suit the needs of all. The intent and purposes are about investments that satisfy the people and the intended organizational objectives.

Human capital comprises many facets and encompasses people, corporations learning institutions, and the economic landscape. The necessities warranting the needs for human capital are mainly based on the demands towards achieving a satisfactory goal for the worker and corporation. Questions remain whether the demand for human capital is feasible enough to create programs that support skills enhancements and worker training initiatives. Corporations must be willing to initiate, support, and sustain the needs for human capital at the local, state, and federal levels.

2.3.1 Investing in Human Capital

Corporations are not the same; each has different objectives and corporate metrics. Where does human capital fit into a corporation's objectives? Questions like this may be left unanswered until there is a need or demand for a particular skill, training, people, and opportunities. Components that support the need for initiating and sustaining employee skills training include programs like the workforce development system are presented in Figure 2.3 on page 16. Figure 2.3 describes the workforce development system's various structures that organize the learning and training of the workforce. Personnel at various stages within the process are placed at certain points throughout the workforce development program diagram. Individuals from the local, state, and federal levels support and drive the program's process flow. At the center of the development system is the employers, who are the driving force for the entire system.

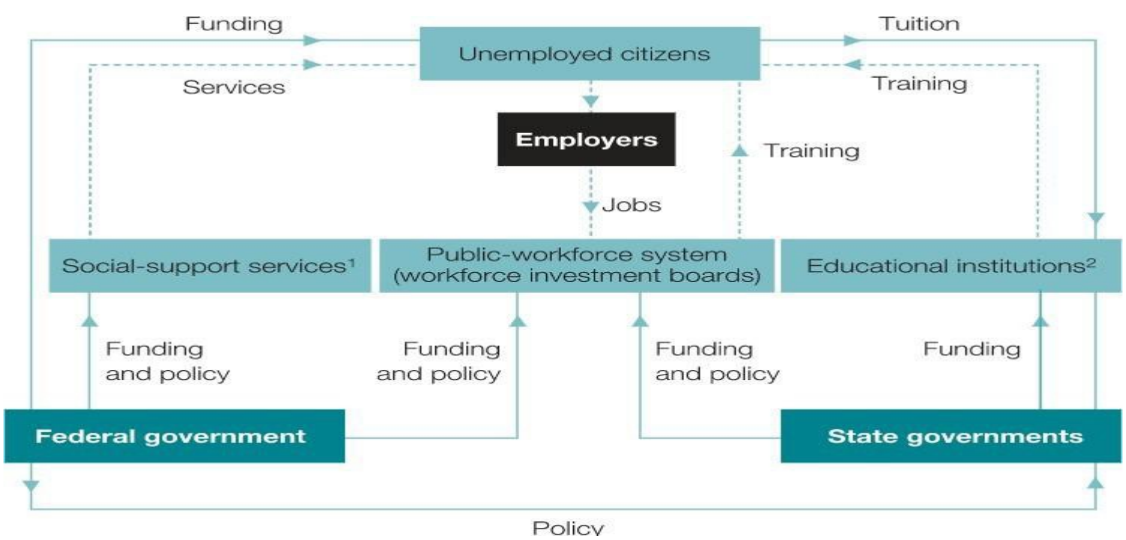

Figure 2.3: The US Workforce-Development System (McKinsey & Company, 2017)

Structures of the workforce development system are paramount to the United States' aim to increase skills within the workforce industry. Systems such as the workforce development system must entail five components, as McKinsey & Company (2017) indicated in Figure 2.4 on page 17. The components include engagement, training modules, curriculum, assessments, and instruction. Each component has a specific purpose in support of effective training concepts. Some of the listed components demonstrate effectiveness, while others may require additional support and repetition to prove effective. Each individual component's description details specific criteria, if achieved, would yield beneficial results.

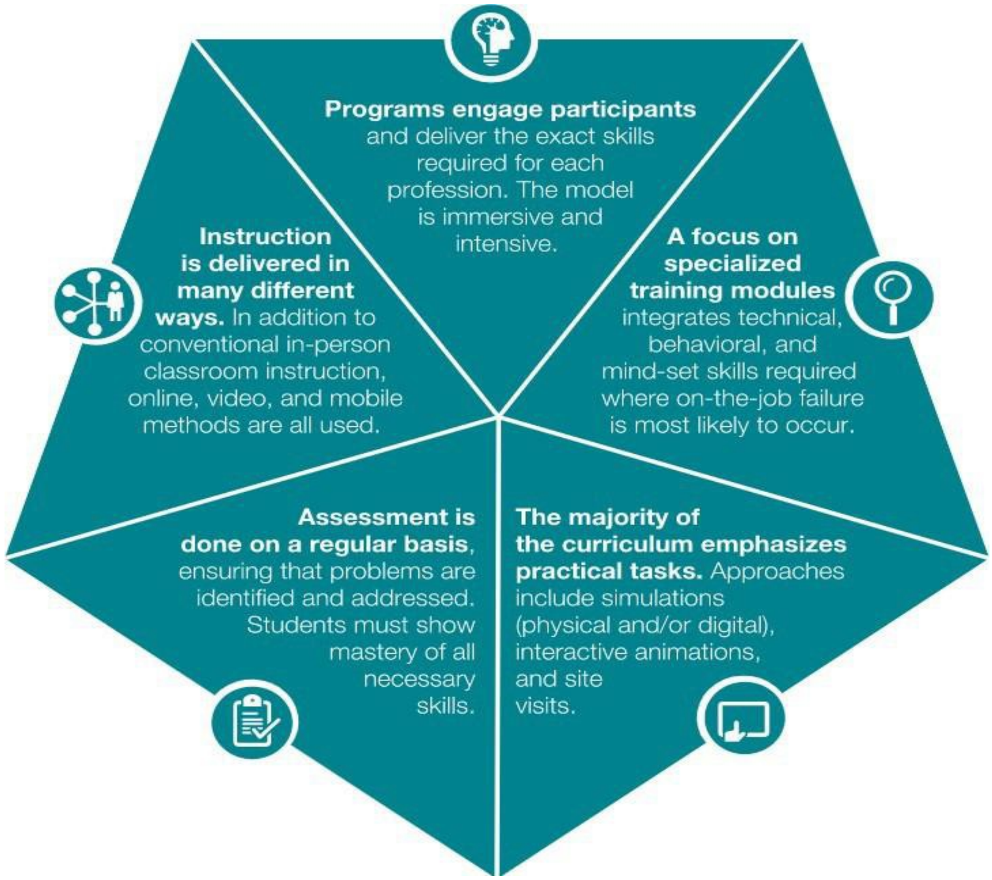

Figure 2.4: Five Components of Effective Training
(McKinsey & Company, 2017)

Data is a vital component in the United States' analytical approach for bridging gaps in acquiring the necessary skills, training, and education for the manufacturing workforce. For instance, Figure 2.5 on page 18 accentuates the necessity. As identified in Figure 2.5 on page 19, data sources come from various inputs and outputs, which result in favorable outcomes. Millennials are indeed the future generation of the workforce. The shift from the past baby boomers and Generation-X necessitates adjustments geared towards skills adjustments. Hanson and Gulish (2016) suggest due to various factors and conditions, the millennial workforce is ill-equipped to meet required advances towards educational attainment. The shift must not only come from on-the-job training practices; it must also incorporate college-level instruction.

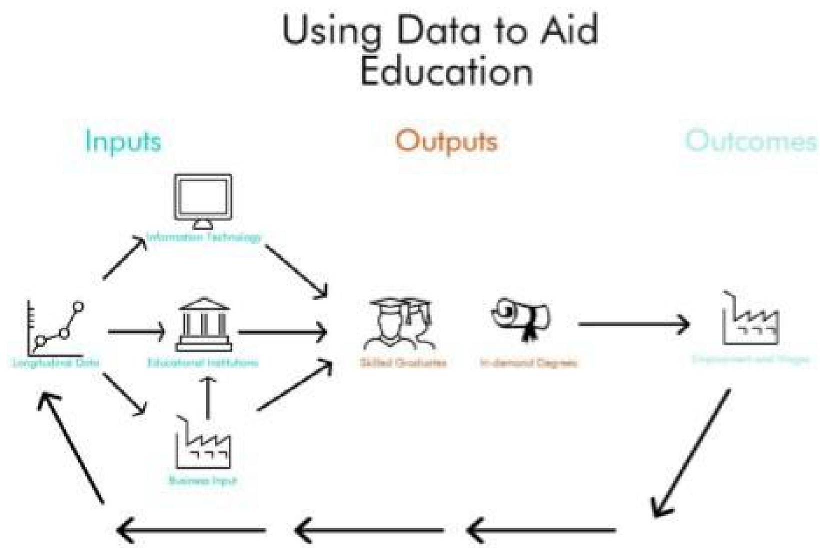

Figure 2.5: Using Data to Aid Education (Hanson & Gulish, 2016)

Millennials are forced to decide whether to go directly to the job market or obtain a vital skill in their pursuit of success. As young adults enter their chosen field, they will find themselves at a crossroads because of the rapid advances in manufacturing technologies. Based on the options in Figure 2.6 on page 19, the opportunities become clearer due to the potential of skill-building that enhances the possibilities for job availability. Once the models and frameworks are set into place, the associated attributes will ensure a smoother transition towards education to job goals. Moreover, higher education institutions, employers, and employees must work and align efforts to ensure all learning possibilities are made available.

Figure 2.6: Education to Employment
(McKinsey & Company, 2017)

Alongside appropriate systems of integration promoting and supporting women in manufacturing, there are programs and opportunities for Learning and Development (L&D). To facilitate the effort to help employees "learn how to learn, L&D teams are building internal knowledge-sharing programs, developing easy-to-use portals and video sharing systems, and promoting collaborative experiences at work that help people constantly learn and share knowledge" (Deloitte, 2016, p. 58). As indicated in Figure 2.7 on page 20, the center of any learning model is the employee – the motivation and assets for the manufacturing industry. Particularly, in addition to the traditional competencies for employee learning, a more broadened approach is required that focuses on where the employee currently stands in their career. The common attributes needed for a successful learning model need not be in any particular order.

Organizational goals include motivating and providing employees with opportunities for improvement, and in return, the employees absorb training and invest in themselves.

Figure 2.7: A Continuous Learning Model (Deloitte, 2016)

Investing in the future is the most common way for an organization and the employee to gain valuable capital and experience. Also, the proper investments, training for developing specific skills are needed within the vast and complex manufacturing sector. The training created and implemented yesterday will not be as relevant for tomorrow. The manners in which the training landscape has changed over time are identified in Figure 2.8 on page 21. More criticalanalysis of change is relevant because the commonalities are employee- and corporate-focused attributes with specific goals for learning methods. Particularly, the future of learning is about recreating and energizing traditional learning with more innovative ways of employee-centered learning.

Today	Tomorrow
Learning is a **series of corporate programs** built around L&D-designed content and L&D-approved experts.	Learning is **an "environment" and an "experience,"** leveraging experts, content, and materials sourced and recommended by external communities as well as by other employees and internal experts (not just L&D).
The learning environment is managed by a **corporate learning management system**—essentially a large catalog filled with courses.	The learning environment feels like a **consumer website** that provides videos, courses, content, and access to experts—as well as recommendation engines that help people find precisely what they need.
L&D, business, and compliance **experts push out training**, identifying required courses to be completed by employees based on roles.	**Employees pull learning**, navigating and accessing opportunities from inside and outside of the company.
The focus is on **internal** training sanctioned by the company.	**External** training is available from any digital content source.
Learning professionals are **generalists** who do everything from design to development, logistics, and measurement.	Learning professionals are **specialists** who are excellent at the component they own.
Training follows a **lecture-based** model guided by an expert.	Training is **experiential**, relying on simulations, case studies, and flipped classrooms.
Employees **learn specific skills** through expert-guided instruction.	Employees **learn how to learn** through facilitation and coaching.
Organizations create detailed, exhaustive, skills-based **competencies** that drive the learning agenda.	Organizations create high-level **frameworks** that outline broad capabilities.
The learning organization plays a **lead role** in what a person learns and focuses on delivering work experiences, interactions with others, and formal training in the traditional 70-20-10 ratio.	The learning organization plays a **supporting role** in what a person learns, expanding the 10 to include "inside" and "outside" learning; shifting the 20 to include internal and external networks; and redefining the 70 to include corporate, community, and social experiences.

Figure 2.8: Learning Today and Tomorrow (Deloitte, 2016)

Moreover, in Figure 2.8, there are over ten ways that employers and organizations use training to fulfill specific goals. The needs can be either employee-specific, employer-specific, or have a corporate component with their distinct requirements. Either way, the bottom line needs to have a useful and beneficial component for all parties involved. The educational system in which to edify the potential workforce is diverse. The needs for training are now more important than ever, given the manufacturing industry's current landscape. Research regarding the manufacturing industry cannot overstress the critical shortcomings for skilled employees.

Corporations and management must identify, enhance and sustain employee training needs. Essentially, a training, education, and skills metric development system would be beneficial in identifying which system works best, as described below in Figure 2.9.

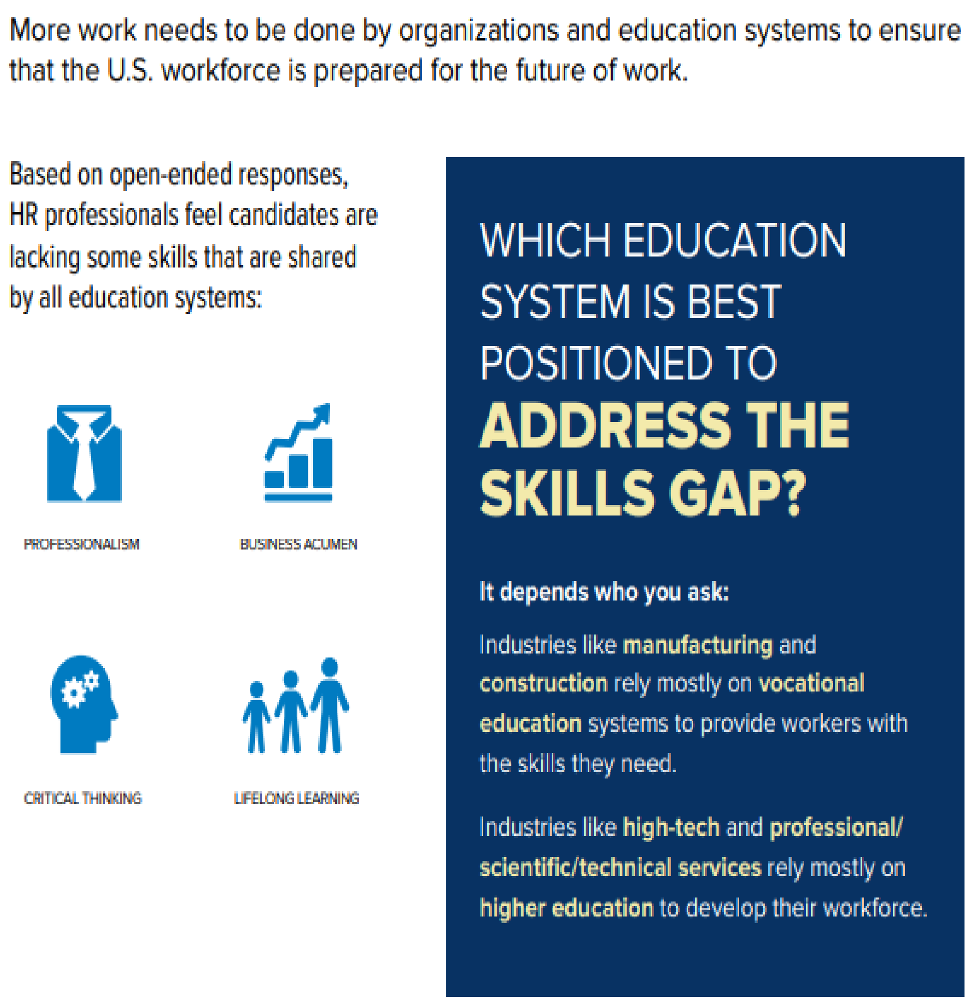

Figure 2.9: Addressing the Skills Gap
(The Society of Human Resources Management, 2019)

After identifying which skills, education, and training metric is best suited for a particular employee, corporations and educational institutions must decide the next best steps. The identification of a suitable education and training method can be an arduous task for all parties involved. One education and training system that works best for one organization may not be appropriate for the next. One possibility that can prove beneficial for all is the implementation of a human capital system of models. The human capital system of models, corporations, and learning institutions are best fit to make decisions regarding employee erudition. Corporations and learning institutions can best link education and training metrics that work best between the Employer and the employee. The following section provides both an overview and a more in-depth look into human capital systems and models.

2.4 Leveraging Human Capital Systems and Model

Aligning with critical tasks and job functions would be critical rated competencies specifically, knowledge, skills, abilities, and personal characteristics. Generic, off-the-shelf job descriptions lack the wealth of job information that fuels the activities of all other human capital management functions. For instance, Hughes (2019) provides the following representation of the components of the system.

Figure 2.10, on page 24, includes more specifics that are paramount for the smooth integration necessary to sustain human capital. Human capital typically includes training measures, occupation level or (job classification), and talent acquisition or skillsets, Hughes (p. 4). The Human Capital Management System (HCMS) includes further measures by including additional metrics, ensuring that all tasks, goals, and opportunities are covered. The inclusion of extra measures works to achieve the best possible employee training and support system, Hughes (p. 4).

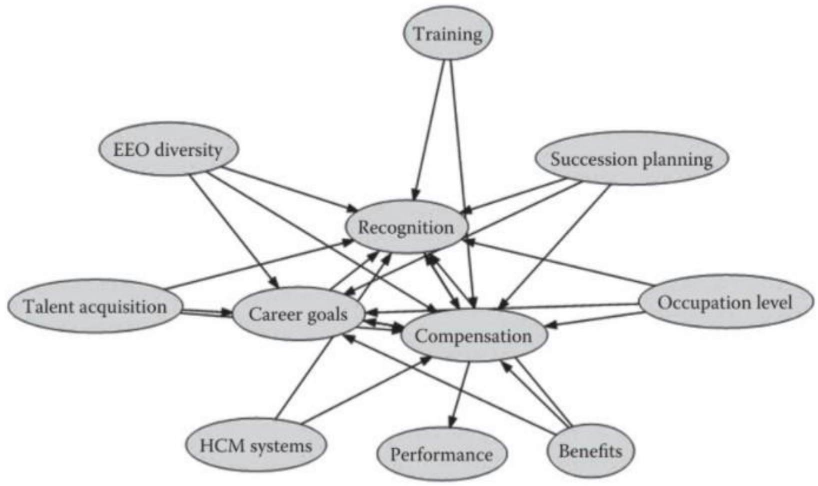

Figure 2.10: Human Capital Management Systems Components and Relationships (Hughes, 2019)

A second human capital system includes the Development Stage of the Dynamic Matching Lifecycle Model. The model in Figure 2.11, employers use education as a signal indicating an able applicant; and search for that signal (education) within the labor market. Furthermore, there are four ways an organization uses this information to find suitable employees within the workforce. As indicated in Figure 2.11 below, the four components of the model are training, socialization, job design, and job crafting.

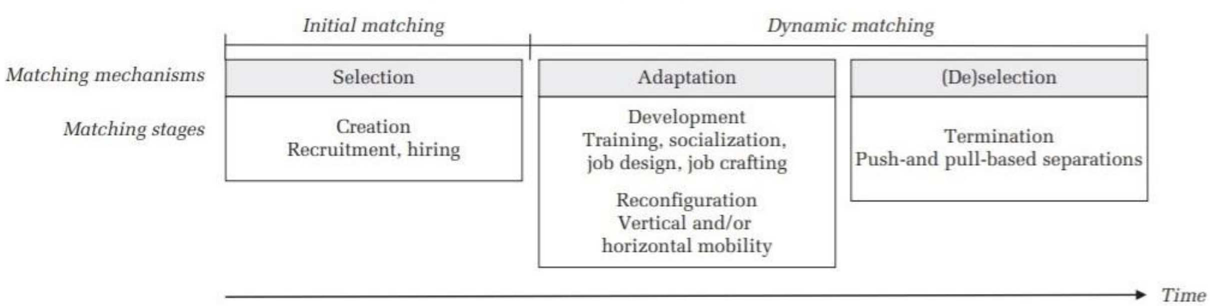

Figure 2.11: Dynamic Matching Lifestyle Model
(Weller, Hymer, Nyberg & Ebert, 2019)

Figure 2.11, on page 24, illustrates the analysis of workers being heterogenous or flexible within their skillsets will further benefit the need for enhancing human capital. Dynamic matching comes into play due to unforeseen circumstances within the job market. When fluctuations occur, heterogenous employees will yield the best results because of their adaptable skills; therefore, providing the best human capital benefits for an organization.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Research Methodology Overview

The project's methodology included research elements with a sample population (N) of ten metal manufacturing companies. The ten companies were primarily Tier-1, Tier-2, and Original Equipment Manufacturer (OEM), suppliers, which supply fabricated metal products to the automotive, aerospace, military, medical, and other products to businesses worldwide. The two research elements included skilled machine operators and unskilled machine operators. The two research elements were analyzed to quantify workers' skills gap. The analysis provided a context to further explore what level of skill existed between skilled and unskilled machine operators.

The research study included 28 data points for each company surveyed. There were seven specific knowledge and skill data points (n) analyzed across four data inputs. The seven specific knowledge and skill data points (n) included: machine safety procedure, compliance work understanding, standard work, machine setup, sample part operation, part operations/running parts, and production/final inspection. Data inputs related to both workers, skilled workers, and unskilled workers, included: training, knowledge/skill level, quality factor, and type of training. Data inputs related to training or the knowledge and skill capacities included having been trained and not being trained. Data inputs related to knowledge/skill level were documented by using a Likert scale. The knowledge and skill levels ranged from no skills, some skills, satisfactory skill, very good skill, up to exemplary skills. Data inputs related to quality factors included acceptable and unacceptable. Data inputs related to the type of training included traditional, on-the-job training (OJT), and apprenticeships.

3.2 Research Instruments

The Purdue Library was the main research instrument used. Additional research instruments used from Purdue included S&P Capital IQ, Mergent Online, and D&B Hoovers. The three research instruments used were all databases for the purpose of collecting data points with company and sample populations, descriptions for gathering specific company profiles with unique information. Included within the company research databases were manufacturing industry-specific Standard Industrial Classification Codes (SIC Codes). The codes are specific to an industry title, Division D: Manufacturing Category. The primary metals industry is 3300, and the fabricated metal products is industry 3400.

3.3 Data Collection Procedures

Company data were acquired by the utilization of research instruments from the Purdue library and other research databases from S&P Capital IQ, Mergent Online, and D&B Hoovers. Additional outlets include appropriate course documents/materials utilized during the ENGT 590b semester. Specific focus was targeted on skilled and unskilled workers within the metals manufacturing industry. The process and procedures used were for the identification of documented and verified worker training that has supported research methodology and thesis hypothesis. The data researched and captured on the skilled and unskilled workers within metals manufacturing has been documented and recorded to validate the disparities between both workers within the industry.

Utilizing Table 3.1, on page 28, a worker analysis was collected and recorded. The manufacturing employee operator analysis table was drawn that included the seven data points (n). Next, the four remaining worker data points were written down and documented:

- Recipient Received Training (Yes/No)
- Knowledge / Skill Level (Likert Scale)
- Quality Factor (Acceptable/Unacceptable
- Type of Training Provided (Traditional/OJT/Apprenticeship)

The rough draft chart was completed and filled out accordingly by researching ten metals manufacturing companies. Calculating the data from the blank sheet of paper was required to validate research accuracy before transferring it into Excel. The collection of data was then transferred onto a completed Excel spreadsheet. The knowledge/skill level attribute was used asa Likert scale for purposes of calculating and documenting worker analysis.

Table 3.1: Manufacturing Employee Operator Analysis

Worker Analysis (n=7)	**Recipient Received Training**		**Knowledge/Skill Level**					**Quality Factor**		**Type of Training Provided**	
	Yes	No	No Skill	Some Skill	Satisfactory Skill	Very Good Skill	Exemplary Skill	Acceptable	Unacceptable	Traditional	OJT
Machine Safety Procedure											
Compliance Work/Understanding											
Standard Work											
Machine Setup											
Sample Part Operation											
Part Operation/Running Parts											
Production/Final Inspection											

3.4 Research Variables

The captured and recorded data from the ten metals manufacturing companies focused on the knowledge and skill levels of the skilled and unskilled workers within the metals manufacturing industry. The research sources included critical company specifics related to operator safety, compliance, standards, machine setup, operations, and inspection processes. The included data gathered has been further categorized into variables identified as groupings that represented skilled and unskilled workers (n) data points.

The project's research sources included the Purdue Library (lib.purdue.edu), focusing on metal manufacturers. The second critical element of the study focused on seven data points related to worker knowledge and skills, and a sample size of ten metal manufacturing companies.

- Machine Safety Procedure
- Compliance / Work Understanding
- Standard Work
- Machine Setup
- Sample Part Operation
- Part Operation / Running Parts
- Production / Final Inspection

3.5 Statistical Measures

Utilizing multiple analyses, seven data points (n) of skilled and unskilled workers from ten metal manufacturing companies were analyzed. Multiple analyses were necessary to ensure statistical significance comparing and contrasting worker knowledge and skills of skilled and unskilled workers.

Using skill rating (i.e., skilled or unskilled) as the independent variable and the rankings from the Likert Scale (0 to 4) as data points, seven t-tests and seven Analyses of Variance (ANOVA) wereconducted. These parametric tests evaluated the variation in the data. To further examine the statistical significance and the distribution of data, a nonparametric test, the Mann-Whitney U Test, was conducted.

3.6 Data Analysis

Table 3.1, on page 28, includes data point descriptions (n) and research elements from ten metal manufacturing companies (N) detailing the descriptions from both skilled and unskilled workers in the metal manufacturing industry. Qualitative analyses were conducted to determine the extent of worker and/or company attributes with specific emphasis on the acquired worker competencies or lack thereof.

- Recipient Received Training
- Knowledge / Skill Level
- Quality Factor
- Type of Training Provided

Complementing the above four worker attributes were seven knowledge and skills data points (n).

The skilled worker analysis described seven (7) data inputs used for all key attributes of skilled workers (n) within the metal manufacturing industry. Each attribute identified both workers having obtained or learned necessary skills and training within the industry, or if additional skills are needed. Additionally, a quality factor and training types will be selected to determine if the skilled worker is proficient within the metals manufacturing industry.

Table 3.1, on page 28, was utilized in two ways. The first manner of utilization was for the analysis of both skilled and unskilled workers combined into one operator analysis. The purpose of this is to better calculate the worker analysis by incorporating both workers. The skilled and unskilled workers were then separated and analyzed into their specific charts for analysis. Next, each category and remaining research element was individually analyzed.

3.7 Limitations

Potential factors that can change the skilled and unskilled worker research study would be the search instruments and specifics within the Purdue Library and the erroneous appraisal of workers. Search methods involving subjects, terminologies, keywords, and phrases, and topics are all subject to greater specificity. Determining the exact keyword and phrasing to achieve a successful study requires more time. The categorizations of workers within the research study were based on corporations' evaluations. The manners in which corporations define "skilled" and "unskilled" workers may be subjective and may not ultimately align with research findings. Moreover, the prominent crucial component of the research study was the validity of the results.

3.8 De-limitations

The study aims to research skilled and unskilled worker data points (n) and a sample size (N) of ten companies. The goal is to research what is required to establish specific boundaries.

CHAPTER 4. RESULTS AND FINDINGS

Metal manufacturing and fabrication machine operator jobs remained limited due to the industry's shortage of skilled operators. Nationally, metal manufacturing machine operator jobs remained unfilled (Queen, 2018). The absence of upskill training for skilled operators, and the lack of initial training opportunities for unskilled workers resulted in the shortage. Multiple data points were analyzed to determine the extent to which workers were trained, and quality factors were directly linked to the worker knowledge data points. Moreover, the research analyzed worker knowledge and/or skill levels.

4.1 Worker Analysis: Skilled and Unskilled Workers

A worker analysis of all ten metal manufacturing companies determined the skill gap between skilled and unskilled workers. As indicated in Table 4.1 on page 33, the research includedseven specific knowledge and skill data points; this totaled 28 data inputs for each of the companies researched. Multiple statistical analyses established substantial differences between data values related to skilled and unskilled workers. The multiple analyses included eight variables: categorizations of workers (skilled or unskilled) and the seven data points. Comparative analyses run via IBM SPSS Statistics necessitated both a specified independent and dependent grouping variable. The categorizations of workers served as the independent grouping variable. To create dependent variable data to compare the groups, the rankings from the Likert Scale (0 to 5) were utilized as data points.

Table 4.1: Manufacturing Employee Operator Analysis

Worker Analysis (n=7)	**Recipient Received Training**		**Knowledge/Skill Level**					**Quality Factor**		**Type of Training Provided**	
	Yes	No	No Skill	Some Skill	Satisfactory Skill	Very Good Skill	Exemplary Skill	Acceptable	Unacceptable	Traditional	OJT
Machine Safety Procedure	2	8	4	2	0	3	1	4	6	2	8
Compliance Work/Understanding	7	3	2	4	0	3	1	8	2	4	6
Standard Work	7	3	3	3	0	3	1	7	3	3	7
Machine Setup	5	5	3	3	0	2	2	4	6	4	6
Sample Part Operation	5	5	6	0	0	3	1	4	6	3	7
Part Operation/Running Parts	4	6	6	0	0	2	2	4	6	2	8
Production/Final Inspection	4	6	6	0	0	0	4	5	5	5	5

Tables 4.2, on page 34, includes the results of the independent samples t-test. Since there were seven dependent variables, the analysis included seven t-tests. Results from the parametric test indicated a statistical difference between skilled and unskilled workers. Despite examining a moderate sample size, the T statistic and p-value revealed a considerable statistical difference.

Table 4.2: Results of the Independent Samples t-test

Data Points	*t*	df	*p*	*M*	SE	95% C.I.	
						Lower	Upper
Machine Safety Procedure	-8.85	8	0.000	-2.92	0.33	-3.68	-2.16
Compliance Work/Understanding	-7.84	8	0.000	-2.58	0.33	-3.34	-1.82
Standard Work	-8.03	8	0.000	-2.75	0.34	-3.54	-1.96
Machine Setup	-8.31	8	0.000	-3.00	0.36	-3.83	-2.17
Sample Part Operation	-16.44	8	0.000	-3.25	0.20	-3.71	-2.79
Production/Final Inspection	-15.34	8	0.000	-3.50	0.23	-4.03	-2.97

Table 4.3 on page 35 includes results of the ANOVA. Since there were seven dependent variables, the analysis included seven ANOVAs. Results from the parametric test indicated a statistical gap between skilled and unskilled workers. Although the test examined a moderate sample size (N), the F statistic and p-value illustrated a considerable statistical difference/variance.

Table 4.3: Results of the ANOVA

Dimension		Sum of Squares	*df*	Mean Square	*F*	*p*
Machine Safety Procedure	Between Groups	20.42	1	20.42	78.40	0.000
	Within Groups	2.08	8	0.26		
	Total	22.50	9			
Compliance Work/Understanding	Between Groups	16.02	1	16.02	61.50	0.000
	Within Groups	2.08	8	0.26		
	Total	18.10	9			
Standard Work	Between Groups	18.15	1	18.15	64.53	0.000
	Within Groups	2.25	8	0.28		
	Total	20.40	9			
Machine Setup	Between Groups	21.60	1	21.60	69.12	0.000
	Within Groups	2.50	8	0.31		
	Total	24.10	9			
Sample Part Operation	Between Groups	25.35	1	25.35	270.40	0.000
	Within Groups	0.75	8	0.09		
	Total	26.10	9			
Part Operation/Running Parts	Between Groups	29.40	1	29.40	235.20	0.000
	Within Groups	1.00	8	0.13		
	Total	30.40	9			
Production/Final Inspection	Between Groups	38.40	1	38.40		
	Within Groups	0.00	8	0.00		
	Total	38.40	9			

The Independent Samples t-test and ANOVA results indicated a statistically noteworthy difference amongst the scores of skilled and unskilled workers. Particularly, there exists a statistical significance across all tested dimensions. Finally, in the t-test table on page 34, the negative mean scores indicated the unskilled workers in the analysis had lower scores than skilled workers tests; SPSS was able to test all seven variables. This difference in the analysis is based on the nonparametric independent samples t-test determined if the same results hold forthe data. As indicated in Table 4.4 by the nonparametric tests, SPSS tested all seven variables. Analysis differences used both nonparametric test methodology and parametric tests as a basis. The parametric tests focused on the scores' variation, while the nonparametric tests focused on the distribution of scores. The Mann-Whitney U Test, indicated by Table 4.4, revealed unskilled workers tended toward lower scores than skilled workers. The results observed and known about

Table 4.4: Mann-Whitney U Test

	Null Hypothesis	Test	*p*	Decision
1	The distribution of MSP Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.
2	The distribution of CWU Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.
3	The distribution of SW Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.
4	The distribution of MS Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.
5	The distribution of SPO Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.
6	The distribution of PO Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.
7	The distribution of PFI Skill Level is the same across categories of Skilled.	Independent-Samples Mann-Whitney U Test	.010	Reject the null hypothesis.

the analyzed data served as a predictor for the included and expected outcomes. The statistical analyses described by Tables 4.2, 4.3, and 4.4 on pages 34, 35, and 36, respectively, offered meaningful results about the research study. Summaries of the Independent-Samples Mann-Whitney U Test are available in the Appendix.

Qualitative analyses of the remaining data points offered additional details. For instance, 50% or more of the companies did not provide training specific to five (71.4%) of the seven data points; the data points were machine safety procedure, compliance work/understanding, standard work, part operation/running parts, and production/final inspection. The area of quality factors divulged comparable findings. Data indicated 50% or more of companies did not identify five (71.4%) of the seven aforementioned data points within their quality metrics. Of the seven data points, the preferred method of training was on-the-job training (OJT).

4.2 Skilled Worker Analysis

Research gathered for the skilled workers within the metals manufacturing industry has shown to be paramount in all areas of analysis. For instance, in Table 4.5 on page 38, one particular area that remained relatively consistent is the data point for recipient received training. One hundred percent (100%) of the skilled workers' knowledge and/or skill levels ranked as either very good or exemplary. The types of machines owned by the companies included: 5-axis CNC machines, metal punch presses, CNC lathes, and horizontal CNC mills. Particularly, 100% of the companies offered training specific to six (85.7%) of the seven data points:

- Compliance Work/Understanding
- Standard Work
- Machine Setup

- Sample Part Operation,
- Part Operation/Running Parts
- Production/Final Inspection

The machine safety procedure distributed results between receiving, and not receiving training, for the remaining data point. Similarly, 100% of the companies identified seven (100%) of the data points within their quality policies or metrics. Of the seven data points, thepreferred method of training was on-the-job training (OJT).

Worker Analysis (n=7)	**Recipient Received Training**		**Knowledge/Skill Level**					**Quality Factor**		**Type of Training Provided**	
	Yes	No	No Skill	Some Skill	Satisfactory Skill	Very Good Skill	Exemplary Skill	Acceptable	Unacceptable	Traditional	OJT
Machine Safety Procedure	2	2	0	0	0	3	1	4	0	2	4
Compliance Work/Understanding	4	0	0	0	0	3	1	4	0	0	2
Standard Work	4	0	0	0	0	3	1	4	0	1	2
Machine Setup	4	0	0	0	0	2	2	4	0	1	2
Sample Part Operation	4	0	0	0	0	3	1	4	0	1	2
Part Operation/Running Parts	4	0	0	0	0	2	2	4	0	1	2
Production/Final Inspection	4	0	0	0	0	0	4	4	0	1	2

Table 4.5: Skilled Worker Analysis

4.3 Unskilled Worker Analysis

Research gathered for the unskilled workers within the metals manufacturing industry has shown to be inadequate in areas of analysis. For instance, as indicated in Table 4.6 on page 40, over 80% of the companies did not offer training specific to the below data points:

- Machine Safety Procedure
- Compliance Work/Understanding
- Standard Work
- Machine Setup
- Sample Part Operation
- Part Operation/Running Parts

One hundred percent (100%) of the unskilled workers' knowledge and/or skill levels were ranked as either no skill or some skill. The type of operated machines included metal punch presses, CNC lathes, CNC mills, drill presses, and welding equipment. Comparable findings were observed in the area of quality factors. Particularly, data indicated that 80% or more companies, did not identify the seven data points within their quality policies or metrics. Of the seven data points, the preferred training method was on-the-job training (OJT), with only one company identified.

Worker Analysis (n=7)	Recipient Received Training		Knowledge/Skill Level					Quality Factor		Type of Training Provided	
	Yes	No	No Skill	Some Skill	Satisfactory Skill	Very Good Skill	Exemplary Skill	Acceptable	Unacceptable	Traditional	OJT
Machine Safety Procedure	0	6	4	2	0	0	0	0	6	0	1
Compliance Work/Understanding	3	3	2	4	0	0	0	4	2	0	1
Standard Work	3	3	3	3	0	0	0	3	3	0	1
Machine Setup	1	5	4	2	0	0	0	1	5	0	1
Sample Part Operation	1	5	6	0	0	0	0	0	6	0	1
Part Operation/Running Parts	0	6	6	0	0	0	0	0	6	0	1
Production/Final Inspection	0	6	6	0	0	0	0	1	5	0	1

Table 4.6: Unskilled Worker Analysis

4.4 Discussion

The manufacturing employee operator project identified the following research problem:

Six out of 10 manufacturing jobs are left unfilled due to the lack of investments in developmental skilled learning and training programs within the United States (Queen, 2018). “Every job in manufacturing creates two and a half new jobs in local goods and services, and for every dollar invested in manufacturing, another $1.32 in additional value is created in other sectors” (Giffi, Dollar and Gangula, 2015, n.p.). The problem will be analyzed by juxtaposing research results of skilled and unskilled workers and the effects on performance, standards, and conditions (Bendoly & Prietula, 2008). Promoting advanced learning methodologies for manufacturing programs will be linked to the National Academy of Engineering Grand Challenge of Advanced Personalized Learning (Zwers, 2010).

Research findings acquired via Independent Samples T-Test, Analysis of Variance (ANOVA), and Mann-Whitney U Test, support various components of the research problem statement. The analysis results suggest that over 75% of companies that did not offer training specific to the seven data points emphasized the lack of investments in developmental training programs. Moreover, failure to identify and correlate worker knowledge/skill levels with company policies or metrics intensified investment deficiency in human capital among corporations. The analysis results championed investing more for training purposes within metals manufacturing; whereby "every job in manufacturing creates two and a half new jobs in local goods and services, and for every dollar invested in manufacturing, another $1.32 in additional value is created in other sectors" (Giffi, Dollar and Gangula, 2015, n.p.).

The results also emphasized the importance of understanding other effects of minimal investments in human capital. For this reason, juxtaposing the results of skilled and unskilled workers and the effects on performance, standards, and conditions served as a mode of analysis (Bendoly & Prietula, 2008). Research findings indicated statistical significance at the Alpha level .05 between skilled and unskilled workers in the areas of analysis. Moreover, unskilled workers tended to have lower scores than skilled workers. Mean scores across the seven data points: Machine Safety Procedure, Compliance Work/Understanding, Standard Work, Machine Setup, Sample Part Operation, Part Operation/Running Parts, Production/Final Inspection; also revealed that the satisfactory skill level across the seven data points was unattainable. For all of the above reasons, it is paramount that companies invest in initial manufacturing employee operator training initiatives. Manufacturing programs linked to the National Academy of Engineering Grand Challenge of Advanced Personalized Learning require more robust company obligations for promoting learning methodologies. (Zwers, 2010).

CHAPTER 5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary

Research conducted included ten metals manufacturing companies and production employees within the metals manufacturing industry. The analysis provided a context further to explore competency levels between skilled and unskilled machine operators. The research includedRecipient Received Training, Knowledge/Skill Level, Quality Factor, Type of Training Provided, that focused on worker analysis within the following areas:

- Machine Safety Procedure
- Compliance/Worker Understanding
- Standard Work
- Machine Setup
- Sample Part Operation
- Part Operation/Running Parts
- Production/Final Inspection

The remaining analysis of the skilled and unskilled machine operators focused on the following worker data inputs:

- Recipient Received Training
- Knowledge/Skill Level
- Quality Factor
- Type of Training Provided

Multiple statistical measures included Analysis of Variance (ANOVA), Mann-Whitney U Test, and T-Test samples to identify the disparity between the machine operators. Qualitative analysis of machine safety procedure, compliance work/understanding, standard work, part operation/running parts, and production/final inspection was conducted. Results indicated that skilled workers were proficient in the following areas: Machine Safety Procedures, Compliance Work/Understanding, Standard Work, Machine Setup, Sample Part Operation, Part Operation/Running Parts, and Production/Final Inspection. Coincidentally, unskilled workers were indicative of a worker who possessed little to no skills in the same areas. The significant outcomes of the study were that there is indeed a skills gap between skilled and unskilled workers. The knowledge and skill capacities of both workers varied from having been trained on specific competencies to not being adequately trained. The alignment of the study findings and extant literature indicates that addressing the "skills gap" between skilled and unskilled workers requires firm, correlated efforts between metals manufacturing industry leaders and educational entities.

5.1.1 Skilled Worker Analysis

The research findings for the skilled workers have shown to be very favorable within all areas of analysis. Results for knowledge/skill levels indicated that 100% of the skilled workers analyzed scored very good or exemplary. The data point for recipient received training showed that over 90% of the workers analyzed had received training. Moreover, aligned training with the seven data points indicated favorable outcomes. For instance, 50% of the skilled workers received training in the area of machine safety procedure. One hundred percent (100%) of the skilled workers received training in compliance/work understanding, standard work, machine setup, sample part operation, part operation/running parts, and production/final inspection. The preferred method of training was on-the-job training (OJT).

5.1.2 Unskilled Worker Analysis

The research findings for the unskilled workers showed a significant difference within critical areas of analysis. Results for knowledge/skill levels indicated that over 80% of the unskilled workers analyzed scored no skill or some skill. The examination for recipients who received training revealed that over 80% of the unskilled workers did not receive training. Mainly, unskilled workers did not receive training in the following five of the seven (or 71% of the) areas of analysis: machine safety procedure, machine setup, sample part operation, part operation/running parts, production/final inspection. Foci of training for unskilled workers were in the areas of compliance/work understanding and standard work. The preferred method of training unskilled workers was on-the-job training (OJT). Findings related to the level and kind of training offered to this group of workers support the notion that six out of 10 manufacturing jobs are left unfilled due to the lack of investment in developmental skilled learning and training programs within the United States (Queen, 2018). Furthermore, the unskilled worker analysis results prove that; effective company obligations are paramount for promoting advanced learning methodologies for manufacturing programs that will be linked to the National Academy of Engineering Grand Challenge of Advanced Personalized Learning (Zwers, 2010).

5.1.3 Statistical Analysis - Skilled and Unskilled Workers

The skilled and unskilled worker statistical analysis included seven specific knowledge and skill data points and 28 data inputs for each of the companies researched. The statistical analyses consisted of three tests: Independent Samples t-test, Analysis of Variance (ANOVA), and Mann-Whitney U Test. The statistical analyses determined statistical significance between data values related to skilled and unskilled workers. The sample t-test and ANOVA results indicated a statistical significance between the two groups of workers. The Mann-Whitney U Test showed that the unskilled workers tended to have lower scores than the skilled workers.

5.2 Informative Analyses of Metals Manufacturing Industry

The metals manufacturing industry's informative analysis consisted of companies that employed workers with varying knowledge and skills. The data collected and analyzed included quality and training results from workers within the Metals Manufacturing Industry. The analysis of the industry has revealed an invalid perception of the industry's workforce. The researched companies presented worker nomenclature representing worker skill sets that did not accurately meet specific company practices. The Worker Analysis, for instance, has seven particular areas that represent the aptitudes of typical metals manufacturing industry workers. Of the seven areas, 50 to 60% of the companies did not offer training related to machine safety procedure, machine setup, sample part operation, part operation/running parts, and production/final inspection. Correspondingly, quality factor findings suggest that these same areas of analysis were not reflected within the companies' quality policies or metrics.

5.3 Conclusions of The Body of Work Within the Capstone Directed Research Project

The Capstone Directed Research Project identified skill differences via three statistical analyses between metals manufacturing workers, and the components of the research study. For instance, the analyses of skilled and unskilled workers suggest that workers lacked training and skills relevant to the worker analysis data points specified within the CDRP.

5.3.1 Interpretations of skilled and unskilled workers

The metals manufacturing industry's analysis of skilled and unskilled workers has been perceived as two separate entities. For instance, according to Hanagan (1977), Marx's Capital describes an artisan worker as "one who was highly skilled, possessed a wide range of skills, and exercised some control over the admission of workers into his trade" (p. 29). Moreover, Kagan (2020) provides the following definition of unskilled workers:

> "a segment of the workforce associated with a limited skill set or minimal economic value for the work performed. Unskilled labor is generally characterized by a lower educational attainment, such as a high school diploma, GED, or lack thereof, and typically results in smaller wages. Work that requires no specific education level or specialized experience is often available to the unskilled labor force" ("para.1").

Similarly, the Capstone Directed Research Project identified a skilled worker as a worker who is qualified within the seven worker analysis data points:

- Machine Safety Procedure
- Compliance Work/Understanding
- Standard Work
- Machine Setup
- Sample Part Operation.
- Part Operation/Running Parts
- Production/Final Inspection

The four worker data inputs listed below were correlated towards worker and company attributes:

- Recipient Received Training

- Knowledge/Skill Level
- Quality Factor
- Type of Training Provided

The analysis results of metals manufacturing workers suggest that favorable worker data results indicated a capable industry worker.

5.3.2 Significance of Shortages of Skilled and Unskilled Workers

Companies within the Metals Manufacturing Industry employed workers that were inexperienced within the industry. The analysis of unskilled worker knowledge aligned with the CDRP's Review of Literature on why organizations struggle to hire suitable candidates. As illustrated in Figure 2.1 on page 7 of the CDRP's Review of Literature, below displays the six reasons organizations struggle to hire qualified candidates.

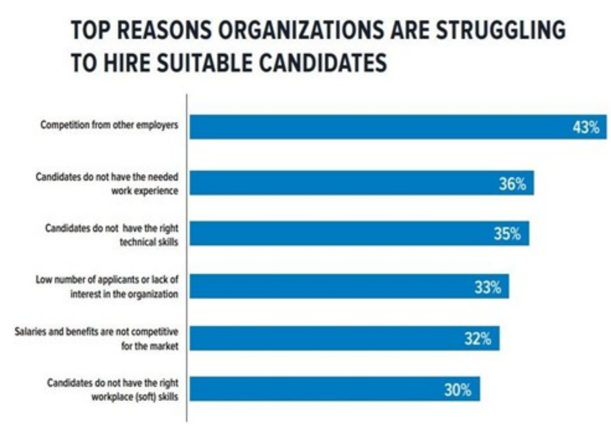

Figure 2.1: Top Reasons Organizations Are Struggling to Hire Suitable Candidates(The Society of Human Resources Management, 2019)

Similar findings associated with the skilled and unskilled worker analyses, the results were identical and in line with current literature. The analysis outcomes for industry workers have shown critical gaps in top areas of company-provided training and receiving training. The previous areas mentioned are significant because worker competencies, company training, and metrics results have correlated with current literature.

5.3.3 Research Findings Limitations/Delimitations

The statistical analysis of the skilled and unskilled workers presented challenges due to various factors. For instance, the company provided data that were collected and analyzed and was not specific to just one type of worker. The worker attributes were grouped according to company profiles, descriptions, and the type of metal manufacturing industry. To fully leverage the analysis, more data with a larger sample size (N) was needed to show some variability between both groups. The modest sample size provided statistical challenges related to variancesof comparing both workers. The larger the sample size (N), the more likely and less complicatedthe analysis tests will become.

One area misrepresented was the company's Machine Safety Procedures. A major finding during the worker analysis was that most companies did not have Machine Safety Procedures. The majority of the companies utilized a company-wide safety policy in place of the Machine Safety Procedure.

5.3.4 Analysis of CDRP Findings

The CDRP addressed worker results based on the four Research Problem Statements. The research results were specific to skilled and unskilled workers within the Metals Manufacturing Industry. The research results of workers within the Metals Manufacturing Industry suggest that the findings align with the literature review for industry workers. Research findings will highlight worker skills deficiency, and the voids in company training processes can be acknowledged and improved. The results are critical towards bridging the gap for identifying qualified, skilled workers within the industry. Critical Worker Knowledge and

Skills Training continues to be the benchmark standardfor recognizing and attracting Metals Manufacturing Industry workers. Suggested methods for attracting qualified industry workers are dependent on Metals Manufacturing Industry leaders' support, correlated with commitments towards sponsored training programs.

5.4 Recommendations

Concluding this study, differences between both groups of workers within Metals Manufacturing are apparent. Key alliances between corporate and educational entities are necessary for ensuring worker training and quality objectives are addressed. The outcome and prioritization for knowledgeable manufacturing industry workers justify improvement in training and quality initiatives. Future skills gap projections and solutions are dependent on the ways companies advance training/learning methodologies. Two recommendations to make such advancements include competency mapping and skills development matrix. Competency mapping (i.e., the process of identifying key competencies of an individual or organization (Choudhary, Sharma, & Mahalawat, 2013; Johri, 2014)), offers companies depictions of workers' skill sets. Two models are recommended. One model depicts a *skilled worker*. A secondmodel represents an *unskilled worker*. A juxtaposition of the two models must occur to quantify the skills attributed to each type of worker and the "skills gap". Such quantifications will provide a context to explore the "skills gap further" in light of an appropriate learning methodology. The process of competency mapping entails a "comprehensive list of competencies which a star performer possesses, along with their level of possession" (Christiana, 2016, p. 8). One of the significant goals of competency mapping is to critique individuals' competency, or lack thereof, to develop or identify appropriate learning methodologies to improve competency (Choudhary, Sharma, & Mahalawat, 2013). The methods for competency mapping are displayed in Figure 5.1. Unlike the competency mapping framework that directlyinvolves the workforce, the proposed mapping entails depictions of the unskilled

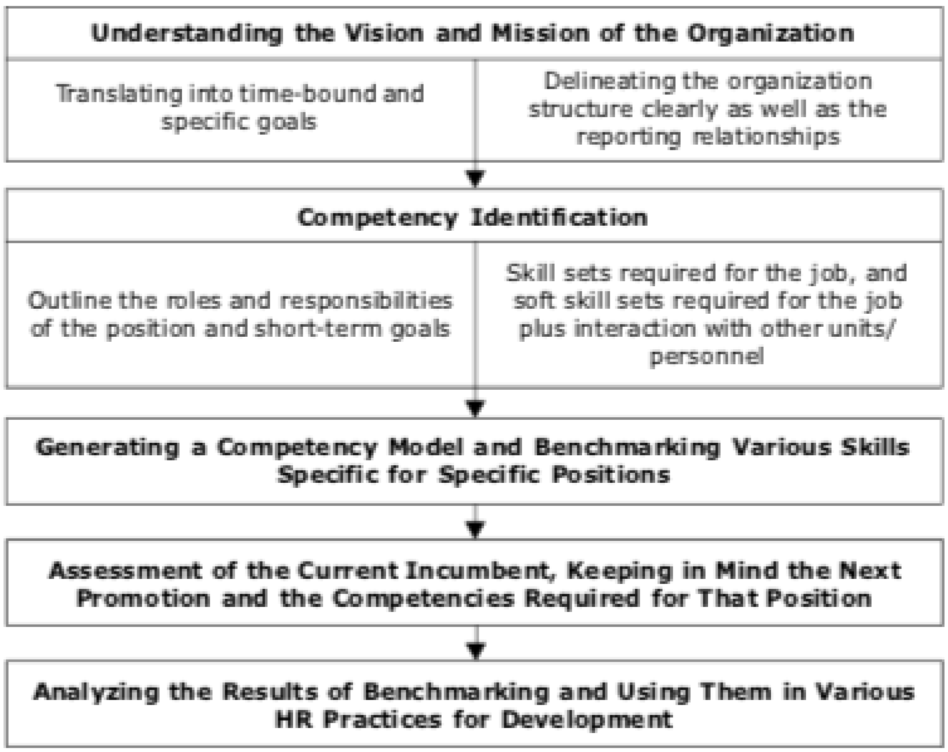

Figure 5.1: Outline of Competency Mapping (Johri, 2014)

and skilled workforce. Table 5.1, on page 51, provides a framework in which to tabulate competency and interest levels; to organize appropriate data to develop competency mappings of skilled workforce and unskilled workforce. Cumulative results need to be utilized to indicate levels for the areas of assessment. Upon completing all tabulations, competency

Table 5.1: Competency and Interest Levels

Areas of Assessment	Unskilled Workforce		Skilled Workforce	
	Competency Level	Interest Level	Competency Level	Interest Level
Core Task Performance				
Citizenship Performance				
Counterproductive Performance				
Standards				
Conditions				

Competency level
0 = Indemonstrable
1 = Demonstrable at a low level
2- Demonstrable at a high level
U- Unspecified

Interest Level
0 = No indication of interest
1 = Indication of interest
U- Unspecified

mappings (or graphs) need to be developed for the unskilled workforce and skilled workforce. For instance, Figure 5.2, on page 53, displays a competency map of a manager from Nagesh, Kulenur, Jagadeesh, 2016). The map indicates the expected results (in blue) and actual results (in green) in relation to the areas of assessment (e.g., job-related competence and skills and attributes). The mapping indicates that the actual results are at or beyond the expected results. Such results suggest that the expected levels of competency of the manager may be too low. The results of this mapping provide a richer context in which to organize learning methodologies to support higher levels of competency in all areas of assessment.

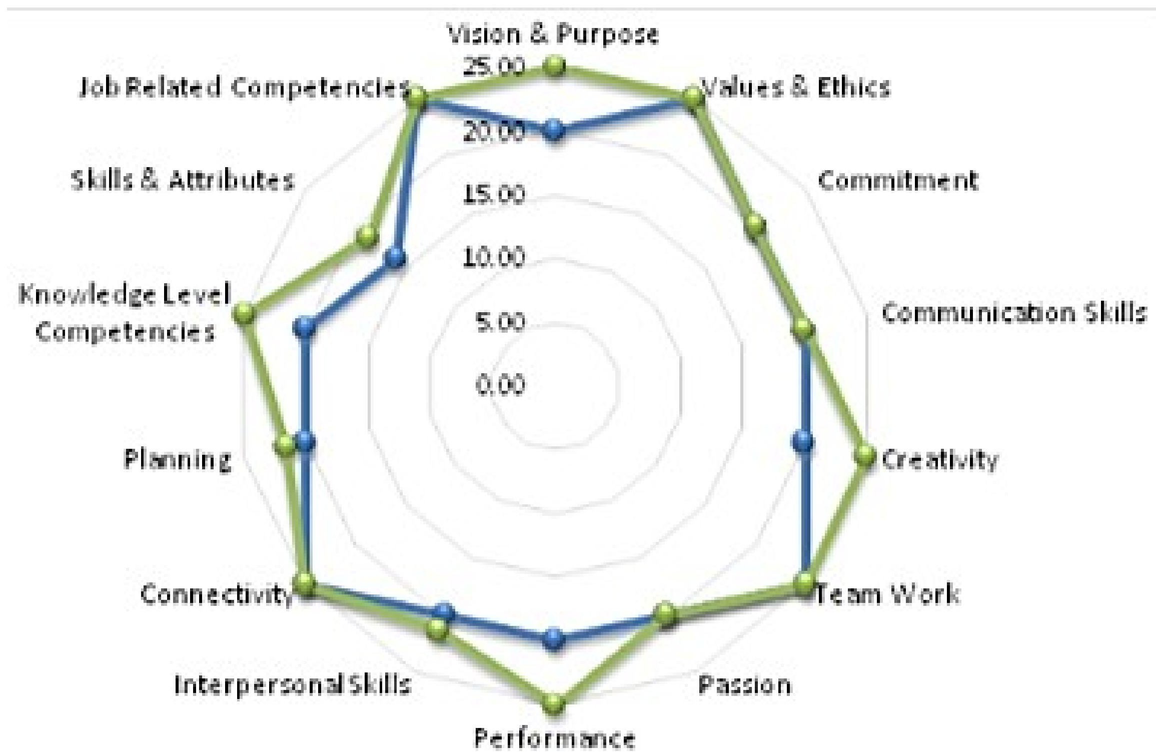

Figure 5.2: Competency Map of Manager (Nagesh, Kulenur & Jagadeesh, 2016)

To further explore the assessment areas, a second model needs to include a skills development matrix (or 2X2 Matrix). The 2X2 Matrix is a universal framework developed to identify a particular deficiency, or lack thereof, and create a matrix for skills improvement and creation (Lowy & Hood, 2004). Upon completing analyses of the competency mappings depicting the skill and unskilled workforce, the 2x2 matrix needs to list and focus on skills development requirements, current skills, and proficiencies. The 2x2 Matrix provides a context in which deficiencies could be aligned with components of a learning methodology to improve competency. As illustrated in Figure 5.3 on page 54, the current features of the 2x2 Matrix include the following categories: low proficiency and high proficiency. The remaining categories need to be determined by analysis of skills. Matrix classifications need to be aligned with components of learning methodologies. The following questions must guide the alignment of matrix classifications and the components of proposedlearning methodologies: What components are beneficial for individuals with low competency level and low-interest level? What components are helpful for individuals with high competency

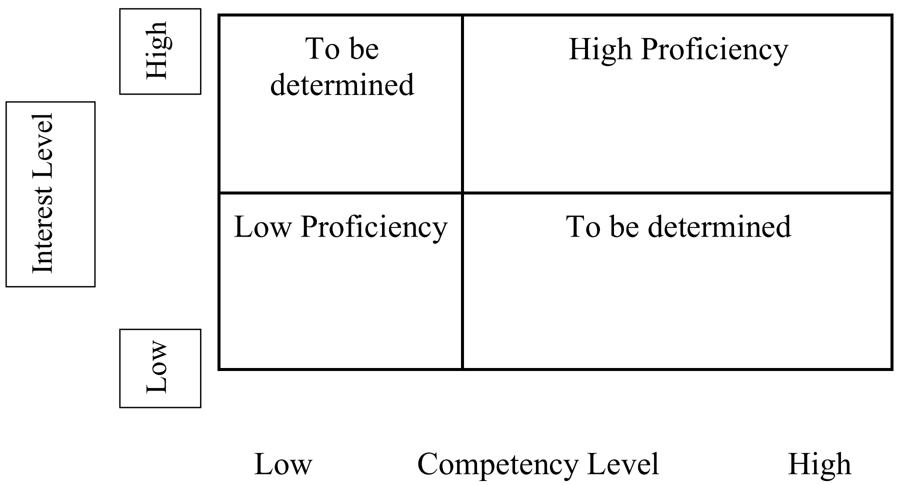

Figure 5.3: Proposed 2x2 Skills Development Matrix

levels and low interest? What components are beneficial for individuals with low competency and high interest? What components are helpful for individuals with high competency and high interest? The intent of the competency mapping and the 2x2 matrix is to highlight the “skills gap” and identify appropriatecomponents of learning methodologies to minimize the gap.

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APPENDIX A
Independent-Samples Mann-Whitney U Test