HUMAN CAPITAL: PRODUCTIVE BENEFITS AND LABOR COMPETENCES

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ABSTRACT

It is widely argued that intangible assets, specifically human capital, are vital to business sustainable growth and differentiation. Thus, extensive research has been conducted on the relationship between human capital, strategy and performance. In this paper, a process to identify the human capital critical competences and to measure their economic benefits/impact is introduced. A total of 40 manufacturers located in San Cristobal-Venezuela were included in this study. From these businesses, 167 lathe/turning machine operators were initially observed and a sample group of sixteen workers across four categories (expert, professional, apprentice and assistant) were analyzed to model their core competences and economic contribution. Evidence suggests that mapping human capital competences with corporate strategies allow businesses to make better decisions in terms of human capital investment, and cost reduction.

INTRODUCTION

The transformation from an industrial-base economy to a knowledge-base economy requires business to allocate greater attention to intangible assets. Human resource scholars widely argue that human capital is among to most important intangible assets and an important source of value generation and of sustainable competitiveness (Becker, Huselid and Ulrich, 2002). However, many organizations face a twofold barrier. First, in many instances, organizations do not have a clear and objective identification of their core human capital competences (aptitudes, knowledge, abilities, etc). That is, an organization has not properly identified which knowledge, aptitudes and abilities are vital to compete effectively and sustainable. Second, organizations often lack a model to objectively and accurately measure the impact of its core human capital competences, "*worker's know-how*" in its manufacturing, market, and financial performance.

Thus, in this study a model to identify and measure such competences is developed for a group of manufacturing companies located in San Cristobal-Venezuela and for a specific processing task, lathe/turning machine operators. The remainder of this article is structured as follows. In section two, a discussion of relevant literature is provided. In section three, the methodology is discussed. In section four, the study results are presented. Finally, section five provides the concluding remarks.

LITERATURE REVIEW

Miller and Wurzburg (1995) introduced a model for "investing in Human Capital." This model has since then being used by many human resources scholars. Miller and Wurzburg raised a vital question, how do we measure human capital in a constantly changing economy? They focus their study primarily on the obstacles to measure the productivity and the value of employee's education. Miller and Wurzburg (1995) argue that learning increases adaptation and constitutes a critical element for business survival and individuals' employability. They claim that "spite of the importance of workers knowledge and skills such as behavioral factors, the methods to measure them not only are notoriously crude, they are also rigidly determined by the institutions that certify them" (p.16).

Miller and Wuzburg (1995) argue that business that intensively use knowledge and skills are faced with three barriers: "(1) *lack of clarity of its labor costs,* in particular those incurred to improve worker's aptitudes; (2) *difficulty in measuring productive capacity,* knowledge, skills and abilities that the workers acquire through training and hands-on experience; (3) inability *to estimate the economic value of aptitudes,* and the enterprises ability to capitalize on the benefits provided by worker's improved aptitudes. That is, businesses are unable to state the "human capital' value in the income statement and balance sheet. They added that unsophisticated means of measuring the value of human capital may lead to incorrect allocations; thus they concluded that organizations need to precisely define their labor costs and measure their employees' competences systematically. This study seeks to identify and define the barriers. Then, provide a systematic model to identify and evaluate human capital for a group of manufacturing companies located in San Cristobal-Venezuela and for a specific processing task, lathe/turning machine operators.

Two additional theories are of interest in this research project, the theory of resources and capacities and the theory of the human capital. The theory of resources and capacities considers businesses as an organized and unique collection of tangible and intangible resources (Wernerfelt, 1984, Carrión and Ortiz, 2000). Each business is formed by a unique combination of resources, which explains its heterogeneity. For a business or enterprise, the resources and capabilities that are difficult to imitate by the competitors are vital to gain sustainable competitive advantages (Grant, 1991, Carrión and Ortiz, 2000). Thus, one may argue that some tangibles assets are easy to imitate whereas intangible assets, e.g. know-how, are perhaps to the most difficult ones to imitate or replicate, and thus intangible assets are closely related to the value of a business (Carrión and Ortiz, 2000). Developing a systematic and precise model to measure human capital, a vital intangible asset, is critical to the survival of any enterprise.

Theodore Schultz (1971), an economist and Novel Prize Laureate, first coined the terms "human capital". He pioneered this line of research and emphatically argued that economic growth depended on "human capital" and that improving the welfare of the poor did not depend on the land or assets, but on knowledge. Fitz-enz (2003) discusses Schultz description of human capital as:

> *"It is necessary to keep in mind all the human capacities, innate or acquired. Each person is born with a specific set of genes, which determines its innate capacity. The acquired attributes, which have value and can be increased through an appropriate investment, will be considered as human capital" (Schultz, 1981, p. 21).*

Becker et al (1964), also an economist and Nobel Prize laureate, devoted a great deal of his work to the concept of the human capital. Becker studied the so-called societies of knowledge and concluded that their greater treasure was the human capital, that is, the knowledge and the abilities of their people, their health and their work ethics. He also defined human capital as important to the productivity of the modern economies, since productivity is based on the creation, diffusion and use of knowledge. According to Becker et al (1964), human capital is the set of productive capacities that an individual acquires by accumulating general or specific knowledge. The notion of capital includes the idea of an immaterial stock possessed by one person that can be accumulated and used. Thus, labor competences are an important part of business entity. Human capital theory provides the basis for the following concepts.

The Human Capital Component of Intellectual Capital

Intellectual Capital is the ability to transform knowledge and other intangible assets into wealth generation for both enterprises and countries (Meroño and Sabater, s/f)). Edvinsson and Malone (1998) defined intellectual capital as "the possession of knowledge, applied experience, organizational technology, relations with clients and professional skills that provide an organization with a competitive advantage in its market". Different models exist for intellectual capital that are based, in essence, on classifying and grouping in a comprehensible scheme each one of the intangible elements that generate or will generate value for the enterprise. The "Intelec Model" is the first Spanish contribution to measure intellectual capital (Euroforum, 1998). The model is structured in three blocks, elements or indicators: Human Capital, Structural Capital and Relational Capital. Human Capital includes the actual competences (knowledge, abilities and attitudes) and the capacity of the people to learn and to create.

Relationship between Human Capital and Work Competency

Work competency can be defined as a worker's capacity to meet and/or exceed a job's requirements or as one's self-image, social role, or a body of knowledge that an employee uses to successfully perform a task (Boyatzis, 1982). These personal characteristics are predictors of excellent performance and are associated with critical behavior (Hay Group, 1996). The Consejo de Normalización y Certificación de Competencia Laboral (CONOCER), (1998) defines Work Competency as the individual's ability to perform a productive task in the same manner. Thus, characteristics such as aptitudes, knowledge, and abilities, among others can be used to approximate human capital and to estimate its value or wealth generation.

Competency Model -Human Capital Approximation

Competency identification is an organization specific task. The organization must identify a set of real, observed and "desirable" behaviors that result in successful performance of a task or job. This profile will generate wealth for the organization. According to Hay Group (2004), a competency model is a complex group of competences related to the challenges and objectives that are pursued in the position or role within an organization. These competencies are interrelated to each other and reflected in the success of the organization. A competency model can be defined for an entire organization, for a division or for a specific role or given job.

METHODOLOGY

Due to the scope of this research project, the methods used were essentially descriptive, and "correlacional" and range from qualitative and quantitative analysis. A qualitative inquiry was used as a naturalistic approach to gain in-depth understanding of phenomena (situation, behavior) in context-specific settings and to possible extrapolates to similar situations (Patton, 1990, Hernandez at el, 1998). Qualitative research is widely argued to be an effective research method when one needs to first identify the variables which will later be tested quantitatively (LaPorte, 1997). Quantitative methods were use to measure the economics impact of the selected workers' competences.

The study was conducted in San Cristobal, Venezuela. Forty for-profit manufacturing companies, classified as lathe-mechanical, were selected for this study. To gain an in-depth understanding of the manufacturing process and thus identify the nodal, or critical task, 167 machine operators were observed within their natural workplace settings (See table 1. It was determined from this population that the lathe/turning machine operators performed the nodal within the manufacturing process. Thus workers' competencies were defined as the independent variable and manufacturing cost as the dependent variable.

Table 1: Study Sample Group

TOTAL BUSINESS ANALIZED	**TOTAL WORKERS OBSERVED**
First generation Lathe-mechanical shops in San Cristobal, Venezuela metropolitan area	Machine operators at first generation Lathe-mechanical shops in San Cristobal, Venezuela
40	**167**

Source: Aguilera (2005)

A census was conducted to identify the stages and critical roles, as well as the indicators of performance of the production process for the lathe mechanical enterprises. Using direct observation of operators in the 40 enterprises, the research group was able to determine common elements within the production processes. In order to generate a suitable competency profile required within the production process, a functional analysis was used on the entire sample (40 enterprises) in consultation with experts.

First, it was determined how many of the 167 workers were lathe operators. That is, operators who performed the lathed tasks that were considered as nodal or critical. A total of 45 lathe operators were identified. Then, owners or shop managers decided which of these operators were considered experts (those having excellent performance). Seniority, 10 years or more in the job, and task proficiency were among the criteria used to classify the workers. According to the shop managers, eight workers met these criteria. Due to conflicting work schedules, some of 16 experts were unable to participate on the next stage of the research project. Thus, a panel of experts comprised of three of the expert operators and two managers with ten years or more of work experience were selected.

A panel of experts, according to Hay Group (1996), has as an objective to transform the challenges of the organization into the required behaviors. The panel of experts will use their knowledge, experience, and available information to determine the individual characteristics that an employee must have in order to perform an assigned task or role with excellence. The experts are generally executives, managers, supervisors and people that know the position or role deeply.

In order to measure the impact of different levels of labor competences in the production process performance, a pre-identified variable from the defined population was selected to discover "predetermined response categories" (Patton, 1990, p 14, Méndez, 1998). Four enterprises had lathe operators in the four levels of competence (expert, professional, apprentice and assistant) for a total of sixteen (16) machining workers of (four levels by enterprise). These individuals were used as the sample to measure the performance indicators.

RESULTS

Detection of Labor Competency in the Production Process

In order to identify the required labor competences to perform a specific production process, functional analysis and an expert's panel was used. CONOCER (1998) argues that functional analysis is the identification of relevant variables breakdown or disintegration into a logical ordering of the production functions of the enterprise. Figures 1 presents a map or results of the functional analysis. Figure 1 shows the production functions necessary to fulfill the main objective of the lathe-mechanical enterprises. It is important to emphasize that through this analysis it was detected that the nodal or the critical area for the lathe-mechanical enterprises is the machining or lathe operations. The machining operations are composed of four sub-areas nominated units of competences. The panel of experts determined the responsibilities, challenges, and behaviors shown on Figure 2. The Table 2 shows the required competency profile for the lathe machine operator using functional analysis and a panel of experts.

Table 2**:** Competency Profile for Lathe Machine Operator.

No	COMPETENCY
1	Capacity to analyze product blueprints or samples to establish the necessary work process, equipment, tools needed
2	Capacity to layout the manufacturing flow and productive process in accordance with established specifications, work method and relevant parameters.
3	Capacity to carry out preliminary operations: selection of draw pieces, cutting and sharpening of tools, reading diagrams, optimization of materials.
4	Capacity to prepare the machines and tools needed.
5	Capacity to adjust tools and parameters to meet technical specification, processing time, quality standards and safety requirements
6	Capacity to place parts properly on the machine to meet security and quality standards
7	Capacity to operate machinery or chip machines to meet quality and safety standards
8	Capacity to determine if finished part meets benchmarking and tolerances requirements, and to recover or eliminate those that do not meet the specifications.
9	Capacity to verify the functionality, quality, precision and coupling of the finished part or project based on engineering specifications.
10	Capacity to take responsibility for his/her performance.
11	Capacity to reduce uncertainty by means of controls and validation
12	Hold himself/herself to higher standards of excellence, constantly seeking training to improve on existing standards of excellence
13	Genuine care for the need of internal (co-workers) and external customers (clients), carefully listen to their needs, and seek to find way to satisfy them.

Figure 1**:** Functional Map of Lathe-Mechanical Enterprises

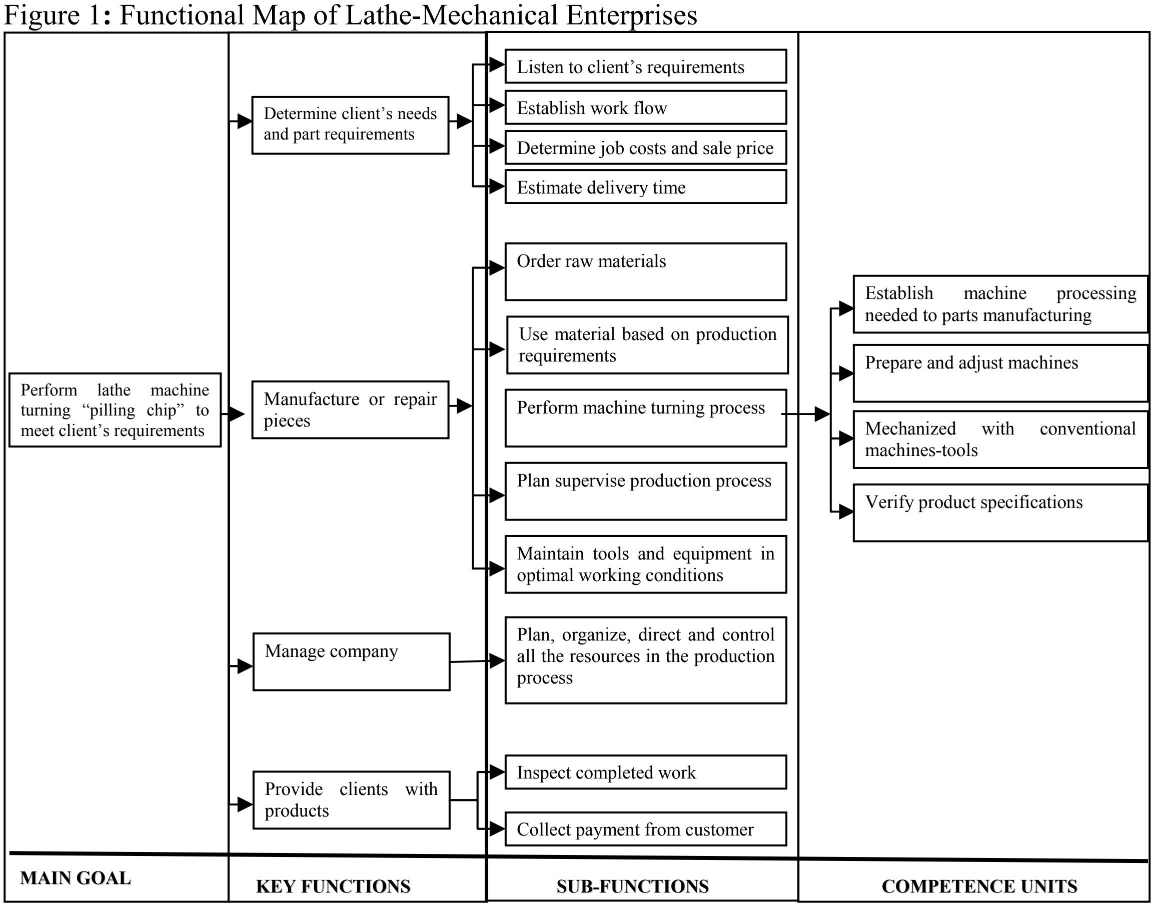
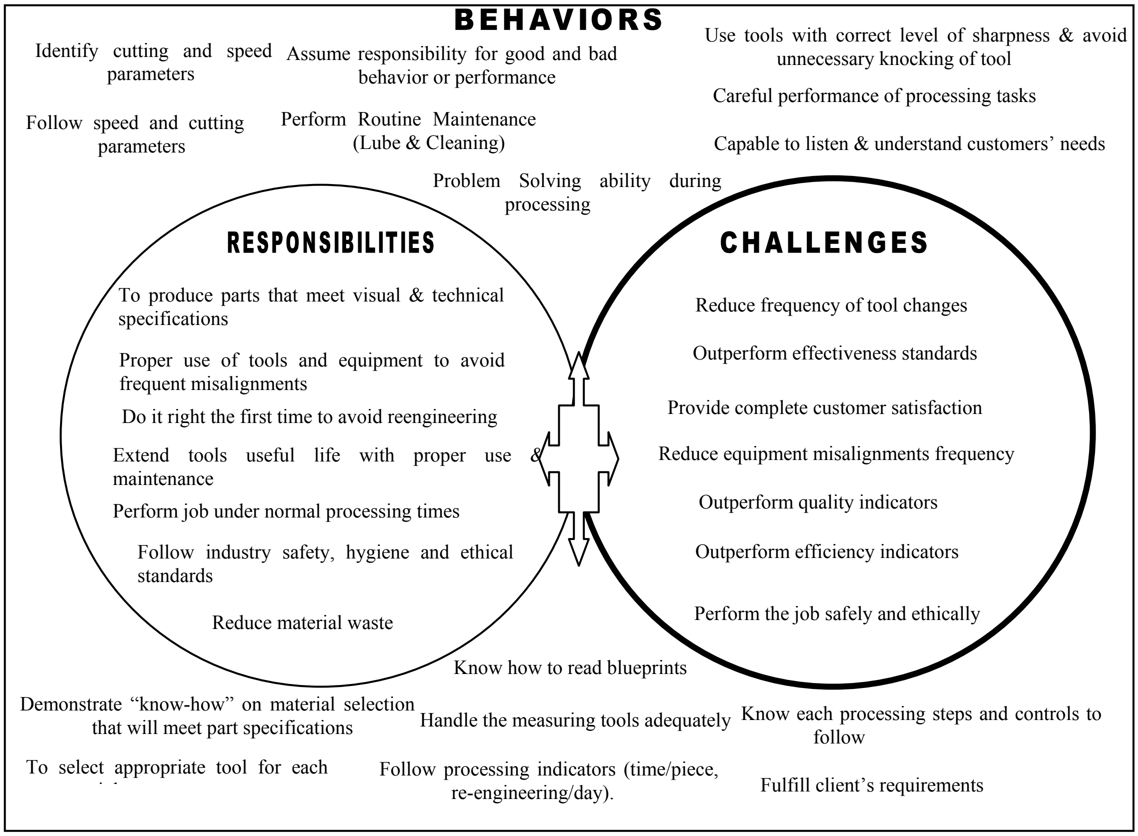


Figure 2: Challenges, Responsibilities and Desirable Behaviors for Lathe Machine Operators



Generation of a System of Indicators Related to the Competency Profile

Competency profiles provide a list of desired behaviors for a particular task or job. However, in the workplace, one may observe individuals with various degrees of such desired behaviors. Thus, a system of indicators will facilitate measuring the impact of diverse competency levels. Besides, measuring the individual's performance during the production process, a system of indicators will measure organizational factors such as efficiency, effectiveness and efficacy (Beltrán, 2000). The indicators of performance for lathe machine operators are showed in Table 3.

Relationship between Indicators and Competency Profile

In order to measure the identified indicators, it was necessary to evaluate the workers competencies at the specific task; thus a performance evaluation form was designed using the competence identified on table 2 as basis. Table 4 shows a sample section of the form related to the first competence from Table 2. This process is repeated for each of the identified competences.

Table 3: Indicators of Performance for Machine Turning Operator.

DIMENSION	INDICATOR	FORMULA
Efficiency	Used time/piece	Measure production time from beginning to end
	Productivity	Total of processed pieces / Total expected pieces
Effectiveness	Number of reprocess	Number of times that a part must be reworked to meet specifications
	Percentage of defects	Number of pieces that do not meet specifications / Total number of pieces processed per unit of time
	Percentage of scrap	Waste materials or material used to redo a piece/ Total material assigned to a part production.
	Cutting tool change frequency	Useful life of cutting tools for a particular worker
	Frequency of equipment misalignment	Number of times the equipment is misalign or out of order
Efficacy	Percentage of parts that met specification	Number of perfectly complete parts / Total number of parts manufactured in a specific time frame
	Percentage of delivery time met	Number of times where actual delivery time meets estimated or project delivery time/ Total number of customers assisted in a specific time frame.
	Customer perception of service provided	Customer qualitative assessment of service provided.

Table 4: Example Questions from the Instrument Used to Evaluate Competences

From a manufacturing diagram and engineering specifications identify shape, cuts, slices and sections needed for a piece or a sets; determine dimension tolerance, surface finish; identify material characteristics, and dimensions for raw piece(s) and finished piece(s).	
Perform the tasks independently and with expertise	□
Perform as routine work	□
Demonstrate theoretical but not practical knowledge	□
Doesn't know how to perform the task	□

A certain level of competency is needed to perform a task. As indicated earlier, there are different levels of competency or mastering of a specific task. Thus, it is important to control for such differing levels (Le Boterf, 2001). Thus, a group of individuals who demonstrated each of the different competency levels were identified. Table 5 shows four levels of competency found for lathe machine operators.

Table 5: Competency Levels for Lathe Machine Operator

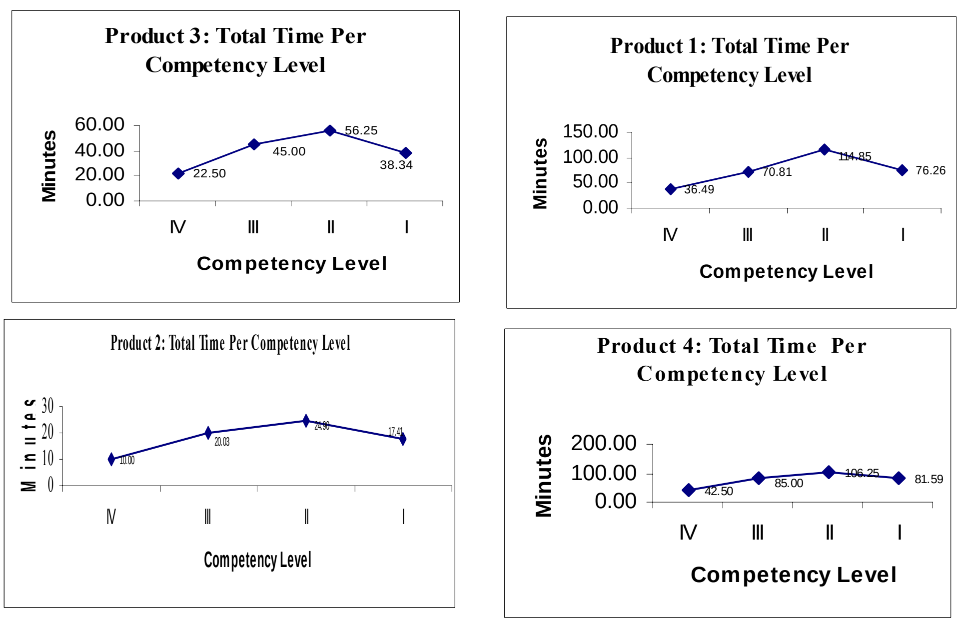
LEVEL	DESCRIPTION
IV	Expert: perform all required processing tasks skillfully and independently.
III	Professional: perform all required processing tasks skillfully, but requires supervisor's assistance form time to time.
II	Apprentice: possess the theoretical knowledge of the production process but lacks practical knowledge; requires constant coworker's or supervisor' assistance. New technical school graduates or Instituto Nacional de Capacitación Educativa (INCE) graduates are included in this category.
I	Assistant: lacks practical and/or theoretical knowledge of the job of machining; supervisor performs the required processing tasks while the assistant observe and learn.

These four levels of competencies were associated with the competency profile (Table 2) and the indicator of performance (Table 3) to determine the time require to perform the lathe machining per type of competency level for four products. Table 6 shows the products analyzed and Figure 3 shows the time required for product one (P1).

Table 6: Products Included in the Study

PRODUCT	CODIGO
Solid Pin (2” x 30 cm) Steel 1006 *Pasador Macizo Ø 2” x 300mm, ACERO 1060*	P1
Axle part for a Volvo bus b10m *Aro soporte estopera tren trasero (autobús volvo b10m)*	P2
Part for a John Deere Backhoe (2”x 40 cm) *Pasador cesto retroexcavador Johan Deere (Series 310,410)* Ø 2” x 400mm. Longitud	P3
Part for a wheel -loader caterpillar 950 (2.5” x 2” x 4”) *Cojinete BrazoPrincipal Pay Loader Caterpillar 950* *(Ø ext. 2, 5”x Øint. 2” x 4 pulg)*	P4

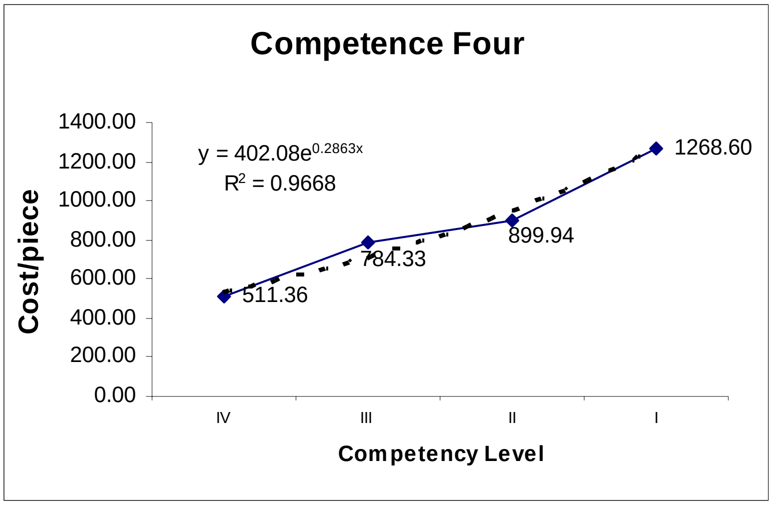
Figure 3: Total Time Required to Manufacture a Piece Based on Competence Level



<u>The Human Capital and Quantification of Its Economic Contribution</u>

Each competence level has a direct impact on processing time. Simultaneously, processing time has a direct impact on labor cost, product quality, reprocessing cost, and maintenance cost. Figure 4 shows the relationship between competency levels and production costs. Figure 3 demonstrates that the impact of the competency level on processing time is the same across products. Thus, to measure the actual impact on production costs, the manufacturing process of a solid pin with dimension 2” wide x 30 cm long made of steel 1060 will be used. Direct and indirect labor costs for four manufacturing companies and across all four competency levels and for all competency profile tasks were obtained. Figure 4 shows the relationship of processing time per unit of production per competence level for competence four (capacity to prepare the machines and tools needed in the production process). The findings are that higher competency levels lower processing costs.

Figure 4: Impact of Competence Four "Capacity to Prepare Machines and Tools Needed in The Production Process" in Lathe Machine Operator Labor Costs.



Next, direct and indirect labor costs for competence one through nine (see table 2) were computed by competence level to arrive to the total cost to produce one part or piece or solid pin steel 1060. Figure 5 illustrates the results for a solid pin made of steel 1060.

Figure 5: Impact of Competency Level on Lathe Machine Operator Labor Costs

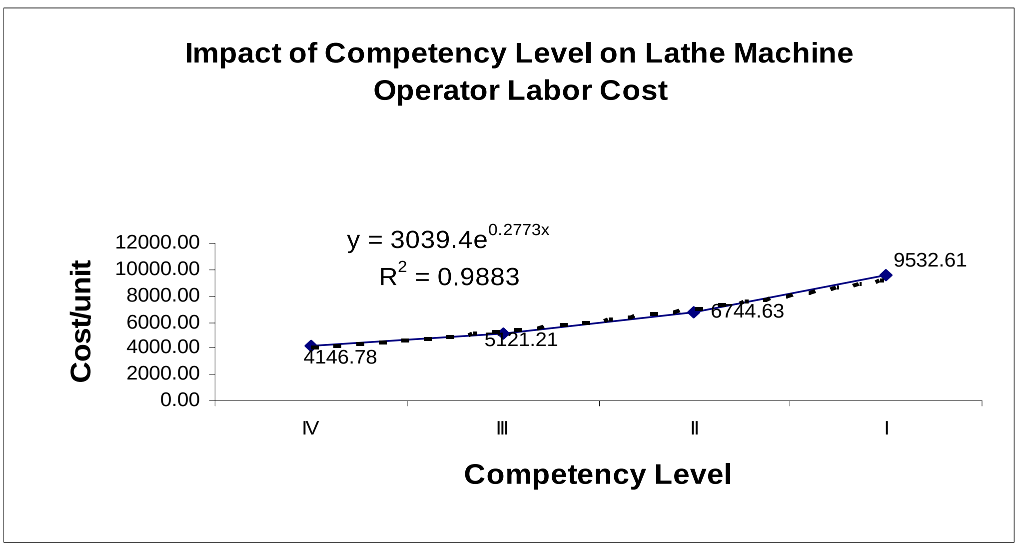


Table 7 summarizes the impact of each competence level on processing time, and labor cost. If a processing task for a worker classified as a professional is compared to that of an apprentice, it can be inferred that an expert processes the part 38% faster than an apprentice. This results in a 24% reduction on labor cost. If a processing tasks for workers classified as an expert is compared to that of a professional, it can be inferred that the expert processes the part 48% faster than a professional implying a 19% reduction on labor cost. Thus, one may argue that training processing workers to become a professional or expert machine operator will have a significant impact on labor costs and consequently manufacturing costs.

Table 7: Processing Time and Costs Reduction by Level of Competency for a Lathe Machine Operator

	Expert		**Professional**	
	Processing Time Reduction	Labor Cost Reduction	Processing Time Reduction	Labor Cost Reduction
Professional	48%	19%		
Apprentice	68%	39%	38%	24%

For comparison purposes, it is assumed that a product price is a function of the cost of the least skillful lathe machine operator. In this case, the least skillful operators are assistants for specific parts, and apprentices for generic ones. Thus, the Ratio de Ganancia por Tipo de Competencia Para Competencias Especificas ($RGTC_{CE}$) or the Ratio of Gain per Type of Competence for Specific Competency and another for a Generic Competency ($RGTC_{CG}$) are estimated. $RGTC_{CE}$ takes labor costs into account and $RGTC_{CG}$ takes reprocessing time and cutting tool cost into account. Tables 8 illustrates the impact in overall cost.

$$RGTC_{EC}(\text{Apprentice}) = \frac{9532.61 - 6744.63}{9532.61} \times 100 = 29\%$$

$$RGTC_{GC}(\text{Expert}) = \frac{13473.92 - 1457.58}{13473.92} \times 100 = 89\%$$

Table 8: Ratio per Type of Competency Level for Lathe Machine Operators

Related Costs	**Levels**			
	Expert	**Professional**	**Apprentice**	**Assistant**
Labor Cost (Bs.)	**4146,78**	**5121,21**	**6744,63**	**9532,61**
$RGTC_{SC}$	57%	46%	29%	0%
Reprocess Cost (Bs.)	1303,03	3366,48	12043,62	------
Cutting Tool Cost (Bs.)	154,55	460,61	1430.30	------
Total Costs for Generic Competences (Bs.)	**1457,58**	**3827,09**	**13473,92**	**------**
$RGTC_{GC}$	89%	72%	0%	------

As stated earlier, competency level has a significant impact on labor cost, cutting tool costs, and reprocessing cost. Thus, the total impact of a competency level on processing costs per piece or part can be approximated. Figure 6 shows cost behavior at different competency levels.

If a constant unit sale price is assumed, and if the tasks are assumed to be performed by an assistant, one may argue that lathe manufacturing companies will have a higher profit margin when a part or unit is processed by an expert worker. The profit ratio increases as expertise increases, approximately 76% ((23006-5604) /23006) *100) in this example. Figure 7 illustrates the cost contribution of human capital if managed and trained properly.

Figure 6: Competence Level Impact on Cost per Unit Manufacture

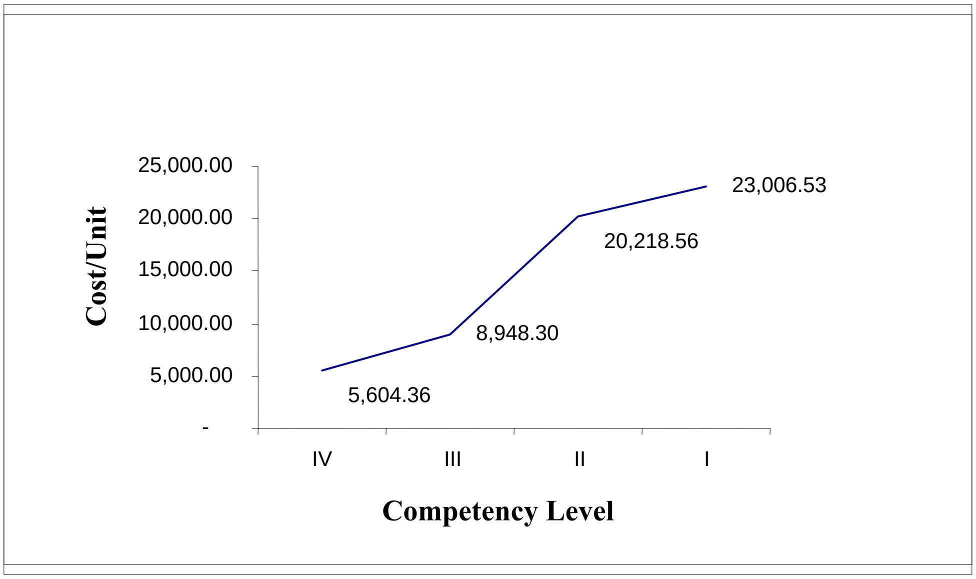
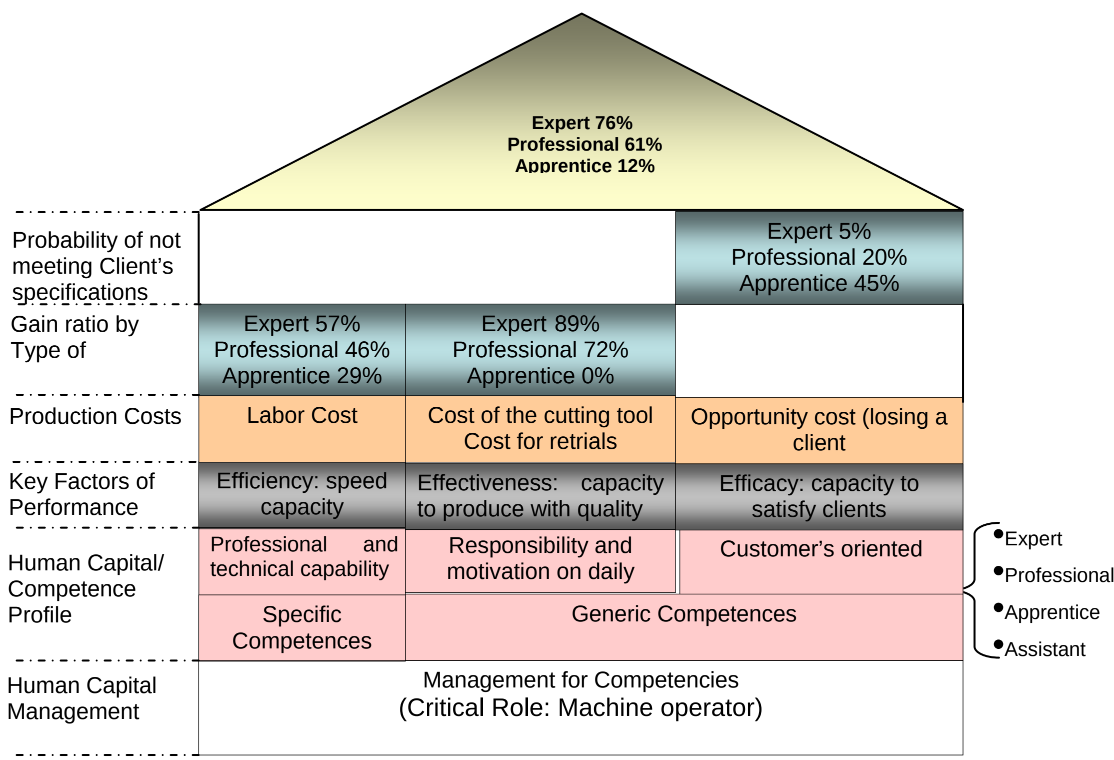


Figure 7: Approximation of the Impact of the Labor Competences on Costs for Lathe-Mechanical Manufactures.



CONCLUSION

This study provides an approximation of human capital contribution in terms costs and labor competencies. This study provides a framework or methodology to quantify Human Capital contribution to the organization profit margin. Future research should more accurate determine the benefit of human capital, and a return on investment should be considered. Further research is also needed in other functional and productive areas of this and other business. This study provides a framework or methodology to quantify Human Capital contribution to the organization profit margin.

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