# Workers' Skills and Receptiveness to Operate Under the Tier II Construction Management Strategy

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**Abstract:** Several diverse factors have contributed to the construction industry's shortages of skilled workers; these factors include decreased real wages, transient nature of work, poor industry image, lack of training, and lack of a worker-oriented career path. The consequent impact of this problem on project performance has been reported with increasing frequency over the last few years. Various studies to address individual issues have resulted in limited successes. However, none of these approaches has comprehensively addressed all the issues within a single framework. A work force management strategy, referred to as Tier II, has been proposed as a comprehensive approach to address the problem. Projects executed under the Tier II strategy would utilize fewer, better-educated and skilled workers who perform craft functions and some lower-management functions and receive higher compensation, while delivering improved or comparable project results. With the participation of industry leaders, labor organizations and experienced craft workers, the strategy and its implementation metric have been developed. This paper presents results from the analysis of baseline data gathered from 20 industrial construction projects located in seven states within the United States, including surveys from over 900 workers. Descriptive analysis of the data gathered showed that the skill levels indicated in the Tier II strategy metrics are feasible and achievable and that the workers already have some Tier II skills, mainly technical skills, but opportunity for improvement is large. Also, this study discovered that the construction workers are receptive to be trained in technical and management skills and operate under specific nontraditional work force management practices that would allow full utilization of those skills. Independently from the potential impact of the Tier II strategy in the success of projects' construction phase, the results of this paper can prove useful for refining the current strategy, devising new ones, or simply for having a better understanding of the work force in order to achieve improved construction work force management practices.

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## Introduction

### *Antecedents of Tier II Strategy*

Shortages of skilled construction workers and their consequential impact on project performance have been reported with increasing frequency over the last few years. Some shortages appear to be regional or within specific crafts. At present, although these shortages are perhaps being partially mitigated by the recent economic downturn, industry stakeholders still consider the lack of skilled workers within their top concerns.

Several diverse factors have contributed to the shortage of skilled workers, including decreased real wages, transient nature of work, poor industry image, lack of training, and lack of a worker-oriented career path ("Only hardworking need apply for image task force" 2000). Organizations such as the National Center for Construction Education and Research, the Center to Protect Workers' Rights (CPWR 2002), and the Construction Users Round Table (CURT 2001) are promoting the need for immediate actions to address the issues of low pay, career-oriented training, and improving the industry's image.

Various studies, referenced in the next section, have previously presented initiatives to address some of these issues offering restricted approaches which have resulted in some moderate successes. However, none of these approaches have comprehensively addressed all the issues within a single framework. A revolutionary approach for work force management is required, based on a strategy that encompasses efforts at all project levels, from the corporate level to each individual worker. The Center for Construction Industry Studies (CCIS) at The Univ. of Texas at Austin, Tex. has proposed a work force management strategy, referred to as Tier II, to address the need for a comprehensive approach to the problem.

With the participation of industry leaders, labor organizations, and experienced highly skilled craft workers, the Tier II strategy has been developed, and metrics for its implementation have been formulated.

### *Related Previous Studies*

The problem of workers shortage in construction (BRT 1983) and the concept of empowering the workers and giving them more

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management-like responsibilities are not new to the construction industry (Seltz-Petrash 1980). Marshall (1996) presents a national strategy based on high-performance production systems as a route for "greater market share, profits, and wages." His strategy is based on the substitution of ideas, skills, and knowledge for physical labor and resources. In addition, encouragement of higher work specialization and work supervision is found in labor productivity studies conducted many years ago (Logcher and Collins 1978). Maloney (1997) proposes a management strategy for human resources in construction, which presents similar elements to those of the Tier II strategy, including broad education for the workers, formal career path, continuous training, knowledge-based pay, and self-managed work teams. On the other hand, Capelli and Neumark (1999) found no evidence that "high performance" work practices, per se, have a positive or negative effect on companies, but firms that choose these practices increase employment compensation without hurting their competitiveness.

In summary, there is evidence that research has been conducted on the different elements proposed under the Tier II strategy and on management practices that support the fundamental concept of this strategy. A few previous studies are directly related to the Tier II strategy as part of the two-tier research program. Some of the various studies have been described in this section, the list is numerous, and it would not be practical to describe them all in this paper. Castaneda et al. (2003) present an extensive discussion on previous studies and industry efforts related to the management practices proposed by the Tier II strategy.

A review of relevant literature makes apparent three main research approaches that have been taken for the improvement of the work force situation over the past 2 decades: quality related practices, labor productivity and workers empowerment, and motivation. An overall evaluation of these previous studies indicates that their results and orientation of the solutions proposed are aligned with the Tier II strategy, whose elements encompass several of these studies into a comprehensive approach.

### Research Motivation

Through its metrics, the Tier II strategy proposes that workers have, or acquire, explicit technical and management skills and that they work under specific project management practices. It is assumed that if the Tier II strategy proves successful, the work force would be ready to attain the Tier II skills and work under the project work practices defined by the Tier II strategy.

For successful implementation of the strategy, there is a need to assess the current levels of workers' skills, and evaluate the workers' receptiveness to Tier II skills and work practices. This information will provide potential implementer firms with knowledge on the level of effort required and a guide for targeting training efforts.

The research results presented in this paper provide that information. First, through descriptive analysis of the baseline data, the current level of competence of the construction work force was determined on the Tier II-defined management and technical skills. Second, the receptiveness of the work force was evaluated for implementation of the Tier II strategy. This evaluation was accomplished through identification of skills gaps and training challenges, as well as the detection of areas of potential conflict for managing workers under the Tier II strategy, from the workers' perspective.

**Table 1.** Tier II Project Index

| Component | Maximum score | Maximum index value |
|---|---|---|
| Project craft technical skills index | 100 | 2.0 |
| Project craft management skills index | 100 | 2.0 |
| Information technology utilization index | 100 | 2.0 |
| Craft utilization index | 100 | 2.0 |
| Organization index | 100 | 2.0 |
| Sum | 500 | |
| Tier II index = (sum score ÷ 50) | ⇒ | 10.0 |

### Review of Tier II Work Force Management Strategy

The Tier II work force management strategy is part of a two-tier strategy proposed by the CCIS to provide a structure for long-term evolution of an improved work force. Brandenburg et al. (2003) and Castaneda et al. (2003) present a complete discussion of the Tier I and Tier II work force strategies, respectively. The focus of this paper is on the Tier II strategy. The reader is encouraged to refer to the sources mentioned for details about the Tier II strategy and its implementation metrics. Nevertheless, the basic elements of the Tier II strategy and its metrics are presented in the following paragraphs in order to provide the background for a better understanding of the discussion and results presented in this paper.

The Tier II strategy is based on utilization of fewer, better-educated, and skilled workers who perform craft functions and some lower-management functions, while delivering improved project results in safety, quality, and schedule at improved or comparable costs. The Tier II strategy emphasizes multiskilling and craftsmen-level management skills, resulting in more productive workers which would receive a skills-based higher wage rate. A new vision of a project management structure is required to fully utilize those higher worker skills. Metrics to assess the level of implementation of the strategy on a given project have been expounded with participation of industry leaders and highly experienced construction workers. The Metric intends to provide not only a measurement system but also criteria for a planned implementation of the Tier II strategy. Chang (2002) presents a comprehensive documentation on the development and details for the evaluation criteria of the Tier II metrics.

The Tier II strategy is defined by the elements that constitute its metrics. The metric used to measure the level of implementation is called a Tier II project index and is measured on a scale of 0–10. The Tier II index for a project is the combined total index of five components: project craft technical skills, project craft management skills, information technology utilization, craft utilization, and organization. As shown in Table 1, each component has a maximum score of 100 points, which divided by 50 yields a maximum potential index score of 2.0 points. Thus, the Tier II project index is merely the sum of the five index scores.

The first two of the five components, the project craft technical skills and project craft management skills, are derived from the scores of the individual's technical skills and management skills scores, representing all of the workers in key craft crews on a project (the project leadership must define the project's key crafts). The project craft technical and management skills indices are based upon the average of the individual's technical and management skills scores for the key craft's workers. The last three components of the metric (information technology utilization,



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**Table 2.** Elements of Tier II Metric

| Tier II metric elements | |
|---|---|
| Components | Elements |
| Craft technical skills | Craft certification |
| | Technical experience |
| | Continuous training and education |
| Craft management skills | Administrative |
| | Computer |
| | Planning |
| | Job management |
| | Work record |
| Information technology utilization | Integrated information access |
| | Hardware |
| Craft utilization | Crew mix |
| | Use of multiskilled workers |
| | Worker turnover |
| Organization | Communications |
| | High-performance work place |

craft utilization, and organization) are the Tier II practices obtained from evaluation of practices at the project level.

A Tier II worker must have both superior technical and management skills. The inclusion of management skills is, in itself, a change in worker expectations and opens new potential career opportunities for ambitious workers. The combined score of technical skills and management skills has a maximum value of 200 points. A minimum combined score of 150 points is necessary to qualify as a Tier II worker. Thus, to qualify as a Tier II worker, it is necessary to have both technical and management skills.

The calculation of each index score is made by dividing the total score by 50, and has a maximum index value of 2.0 points. For the scores of all the components of the Tier II metric, guidelines are given for some of the measures through specific evaluation criteria. A summary of the principal elements that define the components of the Tier II metric are summarized in Table 2.

## Methodology

### *Research Design and Scope*

The study presented in this paper has elements of both descriptive and exploratory research. The objective of the study focuses on assessing and describing the current proficiency of construction workers in the skills proposed by the Tier II strategy, and exploring and describing their receptiveness to the worker skills and practices proposed by the strategy.

The findings of this research study apply to the industrial sector of the construction industry in the United States, from which all the data were gathered, including maintenance and grass root projects. The sample includes data of over 900 workers from 20 different projects in Arizona, Alabama, Florida, Ohio, South Carolina, Tennessee, Texas, Virginia, and West Virginia. The projects visited were volunteered by owners or construction companies willing to participate in the study. The data are considered representative of projects in the industrial sector of the construction industry. The conclusions of this research are drawn for the industry's work force in that particular sector, and for more accuracy, within the states where the studied projects are located.

All the analysis identifying current status and potential challenges for implementation of the Tier II strategy is performed from the workers perspective. The unit of analysis is an individual "worker." Several data elements regarding workers' background and skills were gathered, along with some construction performance data from the projects visited. This data gathering process is expected to continue.

Although the scope of this research is defined within the overall Tier II research program, the results from workers' data analysis are presented in a way that they could prove useful to industry and future workforce research, independently from the advancement and spread of the Tier II strategy as it is currently defined.

### *Data Collection*

Convenience sampling was utilized because the projects from which the workers' data was obtained were not chosen by the researchers. These projects were volunteered by construction or owner companies willing to participate in the study. Also, the sample size is significantly large to draw conclusions about the work force in industrial projects in the region where data were gathered, and the expected variation of results would not be noteworthy if multiple samples of workers were to be drawn from projects with similar characteristics and in the locations described.

A standardized procedure was followed to gather data in each of the studied projects after initial contact was made with the firm (owner or contractor) offering to participate in the study. The major steps of this procedure are described next, in sequential order.

Previous to the site visit, the researchers obtained project information from field management personnel, in addition to coordinating logistics for the site visit. The field management personnel were asked to provide a representative sample of the workers in the site, including workers from all key crafts, and of all skill levels. Project management defined which crafts were considered "key" for a given project. In the project sites, the researcher(s) met with three to four groups of 10–25 craftsmen, and one or two groups of foremen, for 30 min each. After meeting with the groups of craftsmen and foremen, the researcher(s) met with field management personnel to gather project information using a standard questionnaire as a guideline. All the data gathering process for each site was regularly completed within 1 working day.

Three forms/questionnaires were the instruments utilized to gather data:

1. worker skills questionnaire: this questionnaire was used to obtain the data that would be used as input for the Tier II Worker metrics, at a more detailed level;
2. worker profile questionnaire: this questionnaire gathered data regarding background and characteristics of the workers, including their receptiveness and proficiency related to management skills and potential conflicts with Tier II project structure/practices; and
3. tier II management questionnaire: this questionnaire is called "management" because it is used to obtain project information from field management personnel. This questionnaire is the counterpart, for project information, of the worker skills questionnaire. It was also designed to decrease subjectivity when computing the Tier II project index.

Not all the workers provided responses for every question asked



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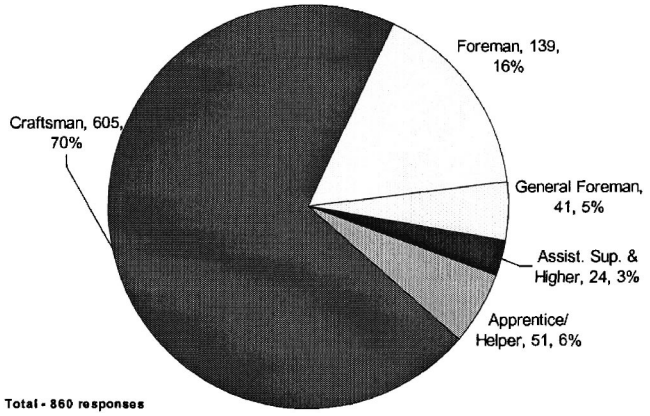


**Fig. 1.** Number of workers interviewed and average years of experience for each position

in the questionnaires; thus the sample size of the workers varies for different pieces of information provided in the results.

## Results of Analysis

### *Descriptive Statistics of Workers Interviewed*

This section summarizes the characteristics of the workers interviewed. It should not be implied that these figures necessarily characterize the entire work force in the construction industry.

It was planned for this research project that most of the workers interviewed would be craftsmen (the more general term "craftsmen" includes "journeymen," which implies union-provided craft certification). The distribution of workers interviewed for each position is presented in Fig. 1. The average years of experience of the workers in each position is noted in Table 3.

In order to have a comparative reference of the characteristics of the work force interviewed, the workers' data gathered were compared to data from a survey of over 1,000 workers from projects throughout the United States, conducted in a study by the Construction Industry Institute (CII) in 1999 (Liska and Piper 1999). Such a document is a more adequate reference than Census derived data because the CII workers' data comes from industrial construction projects, which fall in the same category as that of the workers interviewed for this study. The average years of experience of the workers interviewed is comparable to those shown in the CII 1999 survey, but only slightly higher because not as many apprentices were surveyed.

A principal element of relevance for this study is the level of education of the workers. This information is depicted in Fig. 2, with a histogram of the education level attained by the interviewed workers.

An additional category, "Completed Vocational or Technical Program" is not included in Fig. 2 because it is a training effort that can occur in parallel to the levels of schooling progression shown in the chart, which is the case for several of the workers interviewed. Out of the 853 workers who provided responses, a total of 171 workers (or 20%) completed a vocational or technical program; 52 of them have a level of education of GED equivalent or higher in addition to completing a vocational or technical program.

The level of education of the work force plays an important part in carrying out the Tier II strategy, which requires workers

**Table 3.** Average Years of Experience of Interviewed Workers Per Position

| Position | Avgerage years of experience |
|---|---|
| Apprentice/helper | 6 |
| Craftsmen | 16 |
| Foremen | 21 |
| General foremen | 20 |
| Assistant superintendents and higher | 24 |

that are capable of planning the work, conducting selected management tasks, and having good communication skills, in addition to their high technical skills. The results shown in Fig. 2 indicate a high level of literacy of the construction workers in the industrial projects. Over 70% of the respondents have at least completed high school, and roughly 2% have some college education. Only 6% of them have 0–8 years of schooling. This suggests that there is a feasible opportunity to build upon the workers' educational background and train these workers in the craft management skills proposed under the Tier II strategy. Until this point, it is assumed that the workers would be interested in pursuing training in those skills. This issue is the focus of the workers' training receptiveness analysis presented in this paper.

Similar to the distribution analysis performed for data gathered on the work force years of experience, the age of the workers interviewed was compared with similar data reported in two CII research reports in 1992 and 1999 (Gehrig 1992; Liska and Piper 1999). The average age of workers interviewed during this study appear to be relative higher than the age of workers interviewed in construction projects presented in the CII *Research Rep. No. 135* (Liska and Piper 1999). The CCIS data include fewer workers under 25 and a greater proportion of workers over 50 years old. Also, workers interviewed by CCIS have more years of experience relative to comparable CII data. Nevertheless, the average age of the workers interviewed is 37 years, which is the same as the industry average reported by the Center to Protect Workers' Rights in 1999.

### *Workers' Aggregated Tier II Skills Scores*

Tier II skills scores were computed for 888 construction workers. Workers' Tier II skills data reveal that the workers' Tier II skills scores are normally distributed, as shown in Fig. 3. It is also evident that the "Tier II worker level" is feasible and achievable, and that the metric allows space for assessing the work force skills as they improve.

The cutoff number of 150 points to reach a Tier II worker level was arbitrarily determined to ensure that workers have a good level of both technical and management skills. Therefore, at this point, the number of workers attaining the Tier II worker level is not as important as the fact that the worker skills proposed by the strategy are achievable (Castaneda et al. 2003).

Analysis of frequency charts for technical and management skills, separately, show that the technical skills scores of the workers are higher than their management skills scores. This makes sense. Having construction workers performing selected management tasks in a project is the groundbreaking concept proposed by the Tier II strategy. Currently, workers would not be expected to score high in management skills.

As with the overall Tier II worker skills scores, it is noted that both metrics (for technical and management skills) give an oppor-



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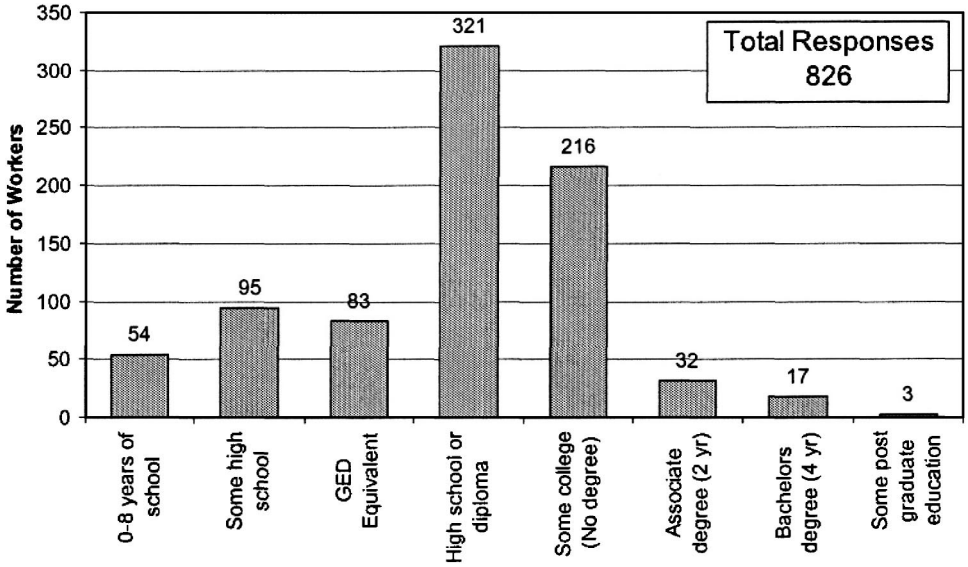


**Fig. 2.** Workers' education level

tunity for future utilization, as the workers' skills improve. In addition, the results show that a fraction of the workers have already some, and in some cases many, of the Tier II management skills. Whether these skills are being fully utilized and recognized by the employers is an issue currently explored as an extension to this research.

### *Work Force Receptiveness Analysis*

The results from evaluating the interviewed workers' receptiveness towards pursuing training in particular skills and working under specific practices proposed under the Tier II strategy are organized in two sections. The first section deals with the willingness of workers to pursue training in the Tier II skills, compared to the corresponding opportunity for improvement in those skills, based on the assessment of workers' current competence levels in those Tier II skills. The second section summarizes the results of the workers receptiveness towards particular work practices proposed under the elements of the Tier II strategy. These results are also compared against the opportunity for improvement in the level of implementation of those Tier II defined work practices, obtained from the Tier II project scores. A detailed discussion of project-level scores is out of the scope of this paper.

**Individual Level: Workers' Receptiveness to Tier II Skills**

In this section, the analysis of workers' Tier II skills is focused on the average score for each particular element of the Tier II worker skills, for all the workers interviewed. The goal was to identify, at an aggregated level, which areas the interviewed workers already have some of the Tier II skills, identify their proficiency in those skills, and the corresponding improvement opportunity. In addition, the improvement opportunity for Tier II worker management skills (based on the Tier II worker metric) is compared against the workers willingness to improve in those skills.

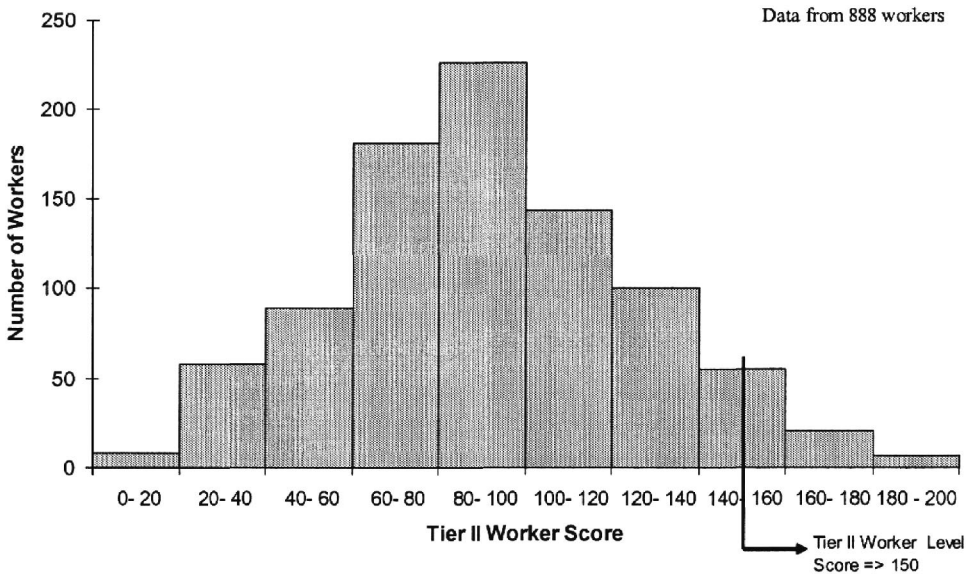


**Fig. 3.** Histogram of tier II worker scores



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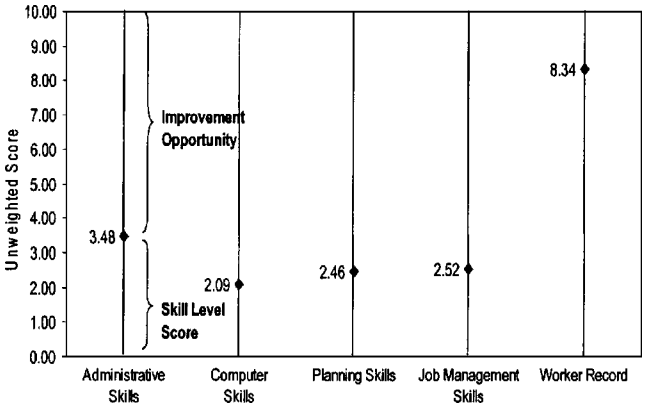


**Fig. 4.** Average tier II worker management skills scores

**Tier II Management Skills: Improvement Opportunity and Receptiveness.** Fig. 4 shows the average score in each element of the Tier II worker management skills. Worker record is not really a skill, but it is presented because it is part of the metric for Tier II worker management skills.

The title of the vertical axis in Fig. 4 indicates that the unweighted scores have been used to have a comparable scale for each skill element (from 1 to 10) based on the metric score, without influencing the outcome with weighting factors, which may be modified in the future when the Tier II strategy is compared against project construction success.

The value of the improvement opportunity is simply the maximum possible score (10 points) minus the average skill score for each variable. Evidently, the average score will hardly reach a value of 10, for this to happen all workers would need to score 10, but this figure serves the purpose of providing a quantified value of potential improvement, which is measured in the same scale for all the elements of the Tier II worker skills metric (see, also, Fig. 5).

The improvement opportunity values for the average management skills of the interviewed workers are: 6.52 for administrative skills, 7.91 for computer skills, 7.54 for planning skills, and 7.48 for job management skills. Overall, as previously discussed, this number indicates that some of the workers already have some level of proficiency but there is opportunity for substantial improvement in all of them.

Whether the workers are willing to improve in those skills through formal training is a simple but key issue evaluated in this study. The interviewees were asked to rate on a scale from 1 to 5 their willingness to undergo training on each of the skills defined by the Tier II strategy, where 1 represents very low interest or receptiveness level and 5 represents very high interest or receptiveness level. The median value of the workers' responses was used to compare receptiveness level versus improvement opportunity level in Fig. 6. The responses of the workers interviewed, depicted in Fig. 6, indicate that they are willing to do so. And no barriers should be expected form the workers in terms of their willingness to improve in management skills. How to implement appropriate training programs is outside of the scope of this investigation; however, the discussion presented is expected to serve as the basis for developing planning strategies for implementation of the Tier II strategy, including training efforts.

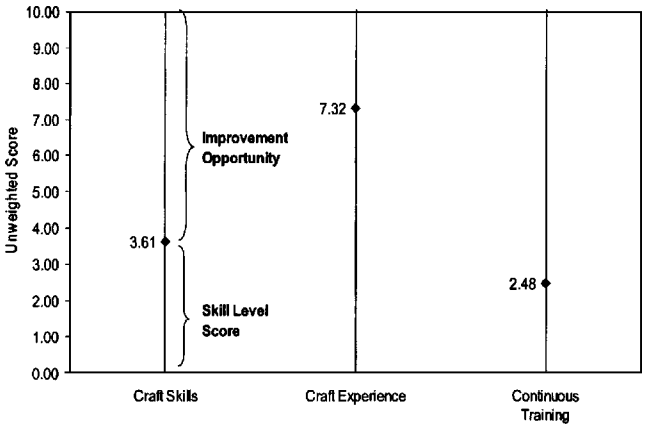


**Fig. 5.** Average of tier II worker technical skills scores

**Tier II Technical Skills: Improvement Opportunity and Receptiveness.** The results presented in this section are based on the same methodology discussed in the preceding section. Fig. 5 shows the average score in each element of the Tier II worker technical skills, for the workers interviewed.

Improvement opportunity values are calculated as in the previous section. Thus, the opportunity improvement values for the craft skills, craft experience, and continuous training scores are 6.39, 2.68, and 7.52, respectively (see Fig. 5).

There is nothing new to construction workers in the elements of Tier II technical skills. It is assumed that their receptiveness to technical skills is higher than, or comparable to, their receptiveness to management skills. Thus, in the case of these technical skills, no particular direct questions were asked to the workers regarding their receptiveness. However, these technical skills are related to other concepts about which the interviewed workers' receptiveness was assessed. The metric measuring craft skills is linked to the concept of multicrafted workers and to the number of crafts in which the workers will become certified within the next year. The average score in craft skills indicates a substantial level of improvement opportunity. The results indicate that the receptiveness to multicrafting depends on whether the worker is in the union or merit shop. About half of the union workers responded that they strongly disagree with the question asked about multicrafted workers/crews, but in general, the majority of workers agreed. Also, in terms of future craft certification, the workers' responses indicate that about 24% of them will become certified in a craft, a few in more than one, within the next year.

With respect to improvement opportunity and workers' receptiveness to continuous training in technical skills, it should also be noted that the opportunity for improvement is substantial, and the receptiveness of the workers is expected to be high, based on their high level of receptiveness to management skills training. Continuous training is an industry problem, thus further discussion of the challenges is presented later in this paper.

Finally, Fig. 5 shows that the average score for craft experience is relatively high, although there is still room for improvement. The high score in this element is not surprising, given that the group of workers interviewed is composed of highly experienced individuals. On the other hand, improvement in this area is directly related to certification, because the years of experience count only after certification in the metric. In this sense, there is no receptiveness to be assessed from the workers regarding years of experience. After certification, this is just a matter of time, depending on the certified workers' tenure in the industry.

**Summary of Skills Gaps and Training Challenges.** The workers' improvement opportunity on the Tier II -defined skills



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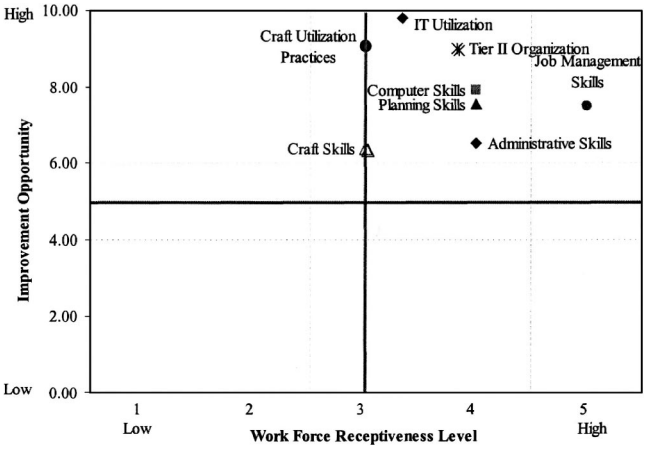


**Fig. 6.** Workforce readiness versus improvement opportunity

and the worker's level of receptiveness to those skills are two dimensions assessing the challenge related to the work force in the execution of the Tier II strategy. The improvement opportunity figures relate to the degree of training needed to raise Tier II worker skills scores. The receptiveness levels studied refer to the potential barriers that could arise from the workers' reluctance or indifference to attain those skills. Fig. 6 presents a comparative evaluation between those two variables, for all elements of Tier II management skills; and for craft skills. The rationale for not presenting an individual receptiveness figure for continuous training and craft experience—the other two elements in the Tier II technical skills metric—was previously discussed.

The values in the vertical axis in Fig. 6, for each element of the Tier II worker skills, are the improvement opportunity values previously defined. The values for the horizontal axis are the median values from the receptiveness scores obtained from the interviewed workers for the Tier II management skills. For craft skills, the median score value from workers receptiveness to the concept of multicrafted workers/crews was used.

The chart area of Fig. 6, divided in four quadrants, facilitates identification of needs versus challenges for prioritizing training efforts ahead of a potential implementation of the Tier II strategy. The results are encouraging. As depicted in the chart, there is a high level of opportunity (i.e., training need) to raise the workers proficiency in Tier II skills, and the workers are ready and willing to improve in those skills.

Different challenges, discussed through this paper, are associated with enhancing the work force's readiness for implementation of the Tier II strategy. Those challenges have varying degrees of complexity, and have been addressed only briefly in this paper.

Certification is one of the major challenges related to the practices proposed by the Tier II strategy. Company certification programs are an increasing trend among merit shop firms; however, the lack of standardization poses a disincentive for construction workers, when their certified skills are not recognized equally across the industry. This industry is slowly moving toward more standardized training and testing standards.

Conversely, the fact that common standards for construction craft certification are in the early stages can be considered an opportunity to integrate management skills into the training curricula and certification for construction workers, and link the progression in both technical and management skills with opportunities for workers' career advancement associated with wages.

Finally, even when all these training-related challenges are overcome, having highly skilled workers requires specific project management structures that utilize the full potential of those workers, and that the workers are able to perform according to those practices. For that reason the receptiveness of the workers toward Tier II project practices was evaluated. The results are summarized in the next section.

### Project Level: Workers' Receptiveness to Tier II Work Practices

As discussed in "Introduction," the Tier II practices are grouped into information technology utilization, craft utilization, and organization. Their metrics are obtained from evaluation of practices at the project level. Castaneda et al. (2003) presents a complete discussion of the Tier II work force strategy, details about its components, practices, and implementation metrics.

The method for assessing the interviewed workers' receptiveness to the Tier II strategy was to evaluate their receptiveness to specific work practices proposed by the strategy; and combine the receptiveness scores (average) for those practices related to each particular component of the Tier II strategy (as defined in the metrics), to obtain an overall receptiveness level for each of these components.

Then, the receptiveness level for each project component of the strategy was compared to its corresponding value of opportunity for improvement, based on the average scores obtained by the studied projects. The improvement opportunity value for each project component (practice) is equal to the maximum possible score according to the scale of the metric (10), minus the average score of all projects studied in that metric component.

Because of editing reasons, the results of the workers' receptiveness to Tier II work practices relative to the improvement opportunity in those practices are presented in Fig. 6, along with the results presented in the preceding section, which refer to the workers' Tier II skills and their receptiveness to improving their skill levels.

The interpretation of the results depicted in Fig. 6 for Tier II practices is similar to those shown for Tier II worker skills. The workers favor implementation of the project work practices proposed by the Tier II strategy, which in turn show significant opportunity for improvement.

Although, the values for the vertical axis (improvement opportunity) are based on average scores from only 20 projects, it is expected that those average component scores for projects studied in the near future will still fall within one of the upper quadrants in the chart.

The values for the work force receptiveness level in Fig. 6 are grouped according to the Tier II project metric component. The answers to receptiveness questions asked to the workers about specific project practices proposed by the Tier II strategy reveal additional information that can prove useful for properly targeting training resources aimed to "selling" the goodness of those practices to the workers, which should be part of a plan for implementing the Tier II strategy; whether the implementation plan is conducted at an industry level once the Tier II strategy is proven successful, or at the company level, for implementation in pilot projects.

The frequency distribution charts of the interviewed workers' responses regarding receptiveness on Tier II project practices were also reviewed in the analysis. Some of the relevant findings inferred from these results confirm expected results, but most of them were revealing. In summary, the relevant results from interviewed workers' receptiveness to specific Tier II practices are as follows:



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1. About 70% of the workers support that planning and progress information should be shared between crews.

2. Only 12% of the workers disagree with the idea of entering and obtaining information in portable wireless computers at the site; however, only over 28% of them think that it is desirable to carry that portable computer on the site. Most workers responded "neutral" to this question. Further questioning of the workers in this respect revealed that the workers' major concern for the use of computers is having to pay for the computer (or hand-held device) if it breaks.

3. About 41% of the workers agree at some level that all crews on a project should include multicrafted workers, but about 26% of them believe that this is not desirable. More than half of the union workers interviewed responded negatively to this question. Only about 10% of merit workers interviewed responded negatively.

4. More than 80% of the interviewed workers agree or strongly agree that the job of the crew should be defined so that crew members see it as a team project, and that all crew members ensure that it is planned and executed properly. The other workers feel neutral about it and only a few disagree.

On the other hand, the results show a divided receptiveness level of workers in terms of whether a rigid chain of command should exist and only the foreman should coordinate the job of the crew. Special attention should be given to this issue combined with the results presented in the previous paragraph. Many of the workers who agree with having the job assigned, planned, and executed as a team, also believe that it should be coordinated only by the foreman based on a rigid chain of command.

In terms of responsibility and accountability for the job performed, a majority of the workers agree that the job of the crew should be assigned so that the entire crew is responsible and accountable for the job performed; but also, the workers have the same opinion about individual responsibility and accountability. Most of the workers who did not agree at some level, answered "neutral." For this concept, as well as for implementation of other practices where a good proportion of the workers feel neutral, the approach presented to the workers previous to implementation and front end preparation could be the difference between failure and success in implementing these practices.

This high frequency of neutral responses is the case for the question asking the workers if it would be easier to get the job done if experienced journeymen were also able to perform tasks that are typically considered "management" functions. Although over 40% of them agree, another similar number of workers feel neutral about it. Again, the explanation given to the workers is relevant to make the strategy work. Some of the workers interviewed perceived this issue as "doing the job of management, for the same pay."

One of the elements in the concept of high performance work organizations incorporated in the Tier II strategy is that workers should adapt to the use of new technology that improves productivity or work conditions. Over 50% of the respondents strongly agree with this issue, which facilitates the advanced practices of information technology utilization proposed by the Tier II strategy.

## Conclusions and Recommendations

Descriptive analysis of the data gathered showed that the skill levels indicated in the Tier II strategy metrics are feasible and achievable and that the workers already have some Tier II skills, mainly technical skills, but opportunity for improvement is large. Also, the results indicate that the workers are receptive to improvement of their Tier II -defined technical and management skills and to work under the construction work force management practices proposed by the Tier II strategy, yet appropriate planning and explanation of the strategy to the workers is recommended to ensure successful implementation.

A natural extension recommended for this study would be to develop a Tier II worker training plan based on the results and the data presented in this study. The issue regarding workers' receptiveness was resolved. However, it is still assumed that management level personnel in construction are willing to work under those practices; and the related training required for management to be able to perform under those practices is unknown. These are only a couple of internal factors that could influence successful implementation of the Tier II (or any) strategy.

Also, when utilizing the Tier II metric for evaluation of worker skills and project practices, it should be considered that the Tier II metric does not evaluate quality of workers' skills or implementation practices. It only gives a quantified value based on whether the skills or the practices are present.

Potential implementers of the Tier II strategy, using the results from this paper for targeting training resources, should give enough importance to presenting the benefits of the Tier II strategy to the work force before, or along, with the initial execution of such practices in a project. This may be the differentiating factor in the workers' receptiveness to the strategy. And the success of the strategy depends in the workers receptiveness. Organizations interested in implementing the Tier II strategy could utilize the methodology presented in this paper to evaluate the workers' Tier II skills levels and their receptiveness to the Tier II strategy in order to target and prioritize training efforts.

On the other hand, if a given company is not able (or willing) to conduct their own work force skills/receptiveness assessment, the results from workers' skills and receptiveness presented in this document could be used to plan appropriate training for implementation of the Tier II strategy. Prioritization of workers' training in the elements of technical or management skills will depend on the project or company internal characteristics and external influencing factors.

In summary, this study discovered that construction workers are receptive to be trained in technical and management skills and operate under specific nontraditional work force management practices that would allow full utilization of those skills.

Independently from the potential impact of the Tier II strategy in construction projects' success, the results of this paper can prove useful for refining the current strategy, devising new ones, or simply for having a better understanding of the work force in order to achieve improved construction work force management practices.

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