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Output Level Improvement in Small and Medium-Sized Manufacturing Enterprises with Regard to Factors Influencing Production-workers

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Abstract

In today's competitive business environment, a six sigma quality output from a conversion process of raw materials to products can be obtained not only by focusing on equipment / machines and materials but also on the production-worker who manages the other two elements. Since the major asset of most Indian manufacturing SMEs is the production-worker who will have a hands-on role in turning out the desired quality output, a more focus is required on this element. A production-worker at work is affected by a set of factors that needs to be addressed to strengthen the overall effectiveness of the worker for a near six sigma level output. In this paper, an attempt is made to examine the influence of various factors on the production-worker by formulating and testing hypotheses. The data for this analysis were collected from production-workers of Small and Medium-sized Manufacturing Enterprises (SMMEs) in north Karnataka through a questionnaire survey. It was found from the study that the output level or 'overall worker effectiveness (OWE)' of a production-worker is influenced by three main factors, viz. personal, technical, and external or environmental. The results show that personal and technical factors have a significant influence on the overall effectiveness of production-worker and hence on the level of output from him/her.

Keywords:
Production-worker, Overall worker effectiveness, Six sigma level output, SMMEs.

1. Introduction

Manufacturing SMEs in India are the major source of supply for most large industries and produce a variety of goods and/services required for end users as well. They have created a huge employment base and contribute significantly to the economy of the nation (Raju, 2008). However, there are problems associated with most discrete products manufacturing SMEs and one of the major problems is the increased rejection rate at various stages of manufacturing process. These rejections affect the desired output level from a process as well as the overall desired output level of the manufacturing enterprise. The rejections in any manufacturing process do take place predominantly because of the basic three '**M**s', viz. men (or women), materials, and machines (or equipment) involved in the conversion process. These *Ms* can broadly be classified as organic components (men or women) and inorganic components (materials and machines) in the process of converting raw material into finished goods. An organic component that is directly involved in the conversion process is the production worker. In a discrete products manufacturing SME, if a sound technology for producing the products is in place and materials are from certified suppliers, it can be argued that the rejections from a process can happen due to the organic component, i.e. production worker.
A production worker is one who has a 'hands-on' role in converting a set of inputs (raw materials) into finished components or products required by the end user or a downstream operation in the manufacturing process. He / she

may be a machine operator, a welder, a pattern maker, an assembly worker, a quality inspector, and so on. A production worker is responsible for turning out the desired output level from a stage of manufacturing and hence the output level of the entire organization. It is for this reason, a production worker is considered to be as important as other production elements.

In this paper, an effort has been made to investigate and analyse the factors that affect the production-worker of discrete manufacturing SMEs and in turn, the output level from the process. The influence of the factors is ensured through testing eight hypotheses.

2. Literature Review

The role of human element in the production process is quite significant. In today's competitive market, customers always tend towards products of higher quality and this high level quality output from any industry depends not only on technology or materials, but also on the human element, especially shop floor people. Hence, human element in today's manufacturing companies is one of the main elements for the success or failure of implementing any new change initiative. Because, the main reasons for the high percentage of systems failure are rarely purely technical in origin (Lou and Alshawi, 2009).

An empirical study by Norsworthy and Zaballa (1985) examines the relationship between *worker attitudes* and productivity in the US automobile industry by means of an extended model of production process. Another study by Fletcher, et al. (2008), in a large manufacturing system found that the workers need to be considered in any manufacturing system design and the extent of variation in workers' performance of production tasks is largely associated with workers' attitudes. Jayan (2006) has shown that there is a correlation between '*job related attitudes*' and the *job performance* of middle level managers. Also, there exists a significantly larger correlation between 'job satisfaction' and job performance, the study reports.

According to a report by KRONOS Inc. (2007), one of the most important and highly variable elements of manufacturing companies is their workforce and optimizing its performance requires companies to establish methods of quantifying, diagnosing, and ultimately predicting the performance of their workforce, and this can be possible by way of improving the Overall Labor effectiveness. The report focuses on the training, skills, workplace conditions and other factors to improve the overall effectiveness of the workforce.

Hiregoudar and Soragaon (2010) have developed a concept called 'overall worker effectiveness (OWE)' and have conducted a study to analyze the factors affecting OWE in manufacturing SMEs. The study has identified three categories of factors that affect a production worker at work.

Over the years, good remuneration has been found to be one of the policies organizations can adopt to increase their workers performance and thereby increase the organization's productivity. Lack of *motivation* in an organization may result in deficiencies in workers' job skill, knowledge, and other areas (Ajila and Abiola, 2004). According to the authors, the future prospects of an employee depend on how well he / she is performing the tasks or job assigned. Also, workers place a great value on the rewards given to them by their employers and lack of rewards and motivation leads to workers dissatisfaction and they show their displeasure by poor performance.

Subramanian, et al. (2009) propose that the efficiency of industrial production is affected by manpower utilization and machine efficiency. The found that the performance of production workers vary from time to time depending on their capability and duration of work and the reason for reduced output is the attitude of workers itself by which they tend to perform in an average manner and for most of the time they will be less productive.

Anu and Sudhakumar (2013) have made a study in construction industry and identified ten factors that affect labour productivity. Of the ten factors, lack of motivation from management side, poor communication, and lack of meetings may be considered common to a production worker in a manufacturing organization.

The results of a study by Danica Bakotić (2016) show the existence of a clear link between employees' job satisfaction and organizational performance in both directions. It is found that the connection between job satisfaction and organizational performance is stronger than the connection between organisational performance and job satisfaction.

Heshmati and Rashidghalam (2016) have studied labour productivity and its determinants in manufacturing and service industries in Kenya. The study has revealed that wage, training and education were the most significant factors affecting labour productivity.

According to Panpuang (2014), there exists a moderate level of correlation between the job attributes such as variety of skills, job clarity, job importance, freedom to do work, etc. and the work efficiency of employees.

Though the labour productivity in German manufacturing industry is strongly affected by considerable investments in research and development (Marija Bušelić and Patricija Pavlišić, 2016), the study has not addressed the factors that

directly or indirectly affect the labours which in turn affect the output level. The authors might be of the opinion that investing in R & D may result in the knowledge level of labours for performing specific tasks.
Hijry and Haleem (2017), in a study in a steel factory, have analysed six factors that influence employee performance. Workplace environment, organizational structure, knowledge, skills, reward, and attitude of the employees are those six factors that influence employee performance. The present research work on output level of production workers makes use of these factors.
There exists a medium level correlation between working motivation factors such as working completion, reorganization, working progression, working characteristic, opportunity, responsibility, management policy, supervision, relationship with their superior, relationship with co-worker, working position, working stability, safety, privacy, working conditions, and payment pertaining to a worker to his/her job performance effectiveness (Kanchanopast, 2013).

It can be concluded from the above review that the production-worker (labour as termed in most articles) in a manufacturing firm is one of the important elements in the conversion process and is influenced by many factors which may hinder the output level from him/her in terms of production rate and the quality of the output. There is a dearth of research work in respect of investigating the factors influencing the output level from a production-worker, especially from manufacturing SMEs sector. A common factor found in most of the studies was 'training' to be offered to the workers on continuous basis in order to improve the firm performance. However, this paper throws a light on other factors - including training - their influence, and the possible remedial actions to be initiated by the top management of manufacturing SMEs.

3. Factors Affecting a Production worker on His / Her Output Level

In support of the conclusions derived from the literature review, a preliminary study was conducted which included collecting the views of experts from industry and academics about what influences the overall effectiveness of production-worker in manufacturing SMEs to achieve a desired output level. With this personal interaction with the experts and the authors' experience, following fourteen factors have been identified as influencing the production-worker at work. The factors so identified have been classified or categorized as *technical, personal, and external or environmental.*

Technical

a. Established production system (system of machines, equipment, tools, etc. for production as well as quality control)
b. Job knowledge (specific and holistic)
c. Job skill
d. Training
e. Experience
f. Qualification

Personal

a. Attitude
b. Health
c. Motivation (financial/non-financial/job satisfaction)
d. Personal issues or problems
e. Behavior

External or Environmental

a. Company culture or Work life
b. Workplace conditions (ergonomics, noise, ventilation, neatness, etc.)
c. Working hours and shifts.

4. Hypotheses

To evaluate the influence of factors identified so on the components of the output level (OWE) of production-workers, the following hypotheses were formulated and tested using suitable statistical tests:

4.1 Influence of Technical Factors on the Performance Efficiency of Production Workers

H0 – The perceived importance of influence of technical factors on the *performance* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of technical factors on the *performance* of production workers differs significantly among different categories of workers.

4.2 Influence of Technical Factors on the Quality Efficiency of Production Workers

H0 – The perceived importance of influence of technical factors on the *output quality* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of technical factors on the *output quality* of production workers differs significantly among different categories of workers.

4.3 Influence of Personal Factors on the Performance Efficiency of Production Workers

H0 – The perceived importance of influence of personal factors on the *performance* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of personal factors on the *performance* of production workers differs significantly among different categories of workers.

4.4 Influence of Personal Factors on the Quality Efficiency of Production Workers

H0 – The perceived importance of influence of personal factors on the *output quality* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of personal factors on the *output quality* of production workers differs significantly among different categories of workers.

4.5 Influence of Personal Factors on the Availability Efficiency of Production Workers

H0 – The perceived importance of influence of personal factors on the *availability* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of personal factors on the *availability* of production workers differs significantly among different categories of workers.

4.6 Influence of External Factors on the Performance Efficiency of Production Workers

H0 – The perceived importance of influence of external factors on the *performance* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of external factors on the *performance* of production workers differs significantly among different categories of workers.

4.7 Influence of External Factors on the Quality Efficiency of Production Workers

H0 – The perceived importance of influence of external factors on the *output quality* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of external factors on the *output quality* of production workers differs significantly among different categories of workers.

4.8 Influence of External Factors on the Availability Efficiency of Production Workers

H0 – The perceived importance of influence of external factors on the *availability* of production workers do not differ significantly among different categories of workers.
H1 - The perceived importance of influence of external factors on the *availability* of production workers differs significantly among different categories of workers.

5. Methodology

5.1 Profile of SMEs

To decide on the target respondents, the data on number and type of manufacturing SMEs was obtained through local government bodies (District Industries Centre, Dharwad and Belagavi) and the local associations of SMEs. Of the 700 and odd SMEs (this includes micro enterprises also) in the researcher's locality, only about fifty manufacturing SMEs were found to be practicing a 'quality management system' and involved in producing a variety of goods. Most SMEs use conventional production technology to produce the goods and rely on skilled production-workers. However, few SMEs use partly automated systems still requiring the intervention of production-workers. The major products produced are 'industrial valves and pumps' (SMEs from Hubballi-Dharwad) and 'cast and forged components used in automobiles' (SMEs from Belagavi). These SMEs cater to the needs of domestic as well as international markets.

5.2 Data Collection

For testing the above hypotheses, it was decided to gather responses of production-workers from fifty ISO certified manufacturing SMEs of above mentioned localities. A reason behind choosing workers from such companies is that the jobs are well defined with respect to the conversion process of a set of inputs into products. Also, a quality management system such as ISO 9000/9001 in place over a period is believed to be a stepping-stone towards the Total Quality Management journey which in turn is a platform for implementing business improvement initiatives such as Six Sigma.

It was decided to choose at least six production-workers of different work nature (e.g. machinist, welder, assembly worker, press tool operator, quality inspector, etc.) from each SME totaling the sample size to 300.

5.3 The Instrument

The questionnaire consisted fifteen items for six *technical factors*, thirty two items for five personal factors, and twelve items for the four external factors. In addition, six general items were used to gather the general (background) information of the respondents. The focus of the items framed in the questionnaire was to check the level of agreement (perceived importance) of factors by the respondents. The questionnaire was prepared both in English as well as in local language since the average education of the respondent was not sufficient to understand the items in English language only. The respondents were asked to rate their level of agreement about the influence of each factor on their output level (effectiveness) based on a 5-level Likert scale. The rating scale ranged from: 1-strongly disagree (SDA), 2- disagree (DA), 3- Undecided (UD), 4- agree (A), and 5- strongly agree (SA). In addition, a scale of `0' was provided to allow for those respondents who did not know or were unsure of the answer. The target respondent in each manufacturing SME was the production-worker who has a direct role in the conversion process of inputs into outputs. A personal contact method was used to obtain the responses. By the preliminary analysis of the data, the production-workers were divided into three different groups, viz. 'Qualified' only, 'Qualified and Experienced', and 'Unqualified but Experienced', based on the responses for items that sought general information of production-workers

5.4 Instrument Validation

The survey instrument used in this study was validated through a reliability test. Cronbach's alpha (α) model was employed to know the homogeneity of the items of the questionnaire. An alpha (α) value equal to or above 0.7 indicates a high internal consistency of the survey instrument (Field, 2005). For the research instrument used in this study, the results of the reliability test revealed that the alpha (α) values are greater than or equal to 0.7 for the items in technical factors, personal factors, and external factors. Hence, it can be concluded that the internal consistency of the instrument is fairly good.

6. Results and Discussion

For the analysis of the data collected, both descriptive and inferential statistical analyses were carried out using Microsoft Excel and SPSS tools. Results of Table 1 below reveal that all the respondents were divided into three main categories, viz. *qualified*, *qualified and experienced*, and *unqualified but experienced*. One respondent was found to

belong to none of the categories. The classification of production-workers into categories was based on the qualification obtained as per the job requirement and the experience (the time spent in years) they have gained on the current job. It was found during the survey that target SMEs have production-workers who are skilled enough to perform the assigned task but do not have a formal qualification for the job. Also, there were *qualified* category workers who possessed a formal qualification for the job but have not completed the stipulated time (minimum three years to be called as an experienced worker) on the job they are doing.

Table 1. Number of respondents with regard to the worker category

Category of the production worker	No. of respondents	Percentage
Qualified	68	27.6
Qualified & experienced	104	42.3
Unqualified but experienced	73	29.7
Unqualified and inexperienced	01	0.4
Total	246	100.0

6.1 Test of Hypotheses

In many cases, one-way ANOVA is used for comparing the means of variable under test for two or more groups. If the means of different groups do not differ significantly, then the test says to accept the null hypothesis, otherwise reject it. However, assumptions such as the data are to be normally distributed and exhibit equal variances for the groups involved are to be satisfied before using ANOVA.
In this research study, the assumption that the test data (scores provided by different categories workers for different factors) must be normally distributed is examined using Kolmogorov-Smirnov and Shapiro-Wilk test. The test is carried out using SPSS 17.0 statistical software tool. The results of normality test revealed that the test variable data is significantly non-normal for all categories of workers at $p < .05$. Also, when tested for equal variances, the data is found to be heterogeneous at $p < .05$. It is therefore decided to use Kruskal-Wallis non-parametric test, an equivalent test to ANOVA that do not assume the normality of test data.

6.1.1 Test of Hypothesis-1

The Kruskal-Wallis test is used to test the hypothesis that the perceived importance of influence of technical factors on the performance differs significantly among different category workers. That is,

$\mathbf{H_0 : \mu_q = \mu_{qe} = \mu_{ue}}$ $\mathbf{H_1 : H_0}$ **is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 2. Kruskal-Wallis test on perceived importance of influence of technical factors on the performance of the workers (Grouping variable: Worker category; Test variable: Group average of scores on technical factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_TP	Qualified	68	69.48
	Qualified & Experienced	104	166.46
	Unqualified but Experienced	73	110.95
	Total	245	

Test Statistics	
	MEAN_TP
Chi-Square (**H**)	80.592
df	2
Asymp. Sig.(**p**)	.000

Results of Kruskal-Wallis test in Table 2 above reveal that the perceived importance of influence of technical factors on the performance differs significantly among different category workers ($H = 80.592$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive technical factors more important (mean rank = 166.46) than 'Qualified' (mean rank = 69.48) and 'Unqualified but Experienced' (mean rank = 110.95) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.2 Test of Hypothesis-2

The Kruskal-Wallis test is further extended to test the hypothesis that the perceived importance of influence of technical factors on the output quality differs significantly among different category workers. That is,

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 3. Kruskal-Wallis test on perceived importance of influence of technical factors on the output quality of the workers (Grouping variable: Worker category; Test variable: Group average of scores on technical factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_TQ	Qualified	68	76.94
	Qualified & Experienced	104	179.20
	Unqualified but Experienced	73	85.84
	Total	245	

Test Statistics	
	MEAN_TQ
Chi-Square (**H**)	114.343
df	2
Asymp. Sig.(**p**)	.000

Results of Kruskal-Wallis test in Table 3 above reveal that the perceived importance of influence of technical factors on the output quality differs significantly among different category workers ($H = 114.34$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive technical factors more important in influencing the output quality (mean rank = 179.20) than 'Qualified' (mean rank = 76.94) and 'Unqualified but Experienced' (mean rank = 85.84) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.3 Test of Hypothesis-3

The Kruskal-Wallis test is further extended to test the hypothesis that the perceived importance of influence of personal factors on the performance differs significantly among different category workers. That is,

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 4. Kruskal-Wallis test on perceived importance of influence of personal factors on the performance of the workers (Grouping variable: Worker category; Test variable: Group average of scores on personal factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_PP	Qualified	68	72.97
	Qualified & Experienced	104	173.41
	Unqualified but Experienced	73	97.78
	Total	245	

Test Statistics	
	MEAN_PP
Chi-Square (**H**)	95.900
df	2
Asymp. Sig.(**p**)	.000

Results of Kruskal-Wallis test in Table 4 reveal that the perceived importance of influence of personal factors on the performance differs significantly among different category workers ($H = 95.90$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive personal factors more important in influencing their performance (mean rank = 173.41) than 'Qualified' (mean rank = 72.97) and 'Unqualified but Experienced' (mean rank = 97.78) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.4 Test of Hypothesis-4

The Kruskal-Wallis test is further extended to test the hypothesis that the perceived importance of influence of personal factors on the output quality differs significantly among different category workers. That is,

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 5. Kruskal-Wallis test on perceived importance of influence of personal factors on the output quality of the workers (Grouping variable: Worker category; Test variable: Group average of scores of personal factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_PQ	Qualified	68	74.99
	Qualified & Experienced	104	160.86
	Unqualified but Experienced	73	113.79
	Total	245	

Test Statistics	
	MEAN_PQ
Chi-Square (**H**)	62.194
df	2
Asymp. Sig.(**p**)	.000

Results of Kruskal-Wallis test in Table 5 above reveal that the perceived importance of influence of personal factors on the output quality differs significantly among different category workers ($H = 62.194$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive personal factors more important in influencing their output quality (mean rank = 160.86) than 'Qualified' (mean rank = 74.99) and 'Unqualified but Experienced' (mean rank = 113.79) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.5 Test of Hypothesis-5

The Kruskal-Wallis test is further extended to test the hypothesis that the perceived importance of influence of personal factors on the availability of production-workers differs significantly among different category workers. That is,

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 6. Kruskal-Wallis test on perceived importance of influence of personal factors on the availability of the workers (Grouping variable: Worker category; Test variable: Group average of scores of personal factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_PA	Qualified	68	68.90
	Qualified & Experienced	104	178.70
	Unqualified but Experienced	73	94.04
	Total	245	

Test Statistics	
	MEAN_PA
Chi-Square (**H**)	116.125
df	2
Asymp. Sig. (**p**)	.000

Results of Kruskal-Wallis test in Table 6 above reveal that the perceived importance of influence of personal factors (overall) on the availability differs significantly among different category workers ($H = 116.125$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive personal factors more important in influencing their availability (mean rank = 178.70) than 'Qualified' (mean rank = 68.90) and

'Unqualified but Experienced' (mean rank = 94.04) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.6 Test of Hypothesis-6

The Kruskal-Wallis test is further extended to test the hypothesis that the perceived importance of influence of external factors on the performance of production-workers differs significantly among different category workers. That is,

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 7. Kruskal-Wallis test on perceived importance of influence of external factors (overall) on the performance of the workers (Grouping variable: Worker category; Test variable: Group average of scores on external factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_EP	Qualified	68	86.18
	Qualified & Experienced	104	148.97
	Unqualified but Experienced	73	120.30
	Total	245	

Test Statistics	
	MEAN_EP
Chi-Square (**H**)	33.127
df	2
Asymp. Sig.(**p**)	.000

Results of Kruskal-Wallis test in Table 7 reveal that the perceived importance of influence of external factors on the performance differs significantly among different category workers ($H = 33.127$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive external factors more important (mean rank = 148.97) than 'Qualified' (mean rank = 86.18) and 'Unqualified but Experienced' (mean rank = 120.30) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.7 Test of Hypothesis-7

The Kruskal-Wallis test is further extended to test the hypothesis that the perceived importance of influence of external factors on the output quality of production-workers differs significantly among different category workers. That is,

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 8. Kruskal-Wallis test on perceived importance of influence of external factors (overall) on the output quality of the workers (Grouping variable: Worker category; Test variable: Group average of scores on external factors)

Ranks			
	Worker Category	**N**	**Mean Rank**
MEAN_EQ	Qualified	68	81.92
	Qualified & Experienced	104	152.14
	Unqualified but Experienced	73	119.75
	Total	245	

Test Statistics	
	MEAN_EQ
Chi-Square (**H**)	41.231
df	2
Asymp. Sig.(**p**)	.000

Results of Kruskal-Wallis test in Table 8 above reveal that the perceived importance of influence of external factors on the output quality differs significantly among different category workers ($H = 41.231$, $p < .05$). Also, it is found that 'Qualified and Experienced' category workers perceive external factors more important (mean rank = 152.14) than 'Qualified' (mean rank = 81.92) and 'Unqualified but Experienced' (mean rank = 119.75) category workers. ***From the above test, it can be concluded that null hypothesis is rejected.***

6.1.8 Test of Hypothesis-8

It is found during the analysis that among the four external factors identified, only ‘‘*working hours and shifts’* is perceived important in influencing the workers (Mean and Median values ≥ 3). Hence, the hypothesis is tested only for this factor. That is,
H0 - The perceived importance of influence of ‘working hours and shifts’ on the *availability* of production workers do not differ significantly among different categories.
H1 - The perceived importance of influence of ‘working hours and shifts’ on the *availability* of production workers differ significantly among different categories.

$H_0 : \mu_q = \mu_{qe} = \mu_{ue}$ **$H_1 : H_0$ is not true**

q: Qualified Worker
qe: Qualified and Experienced Worker
ue: Unqualified but Experienced Worker

Table 9. Kruskal-Wallis test on perceived importance of influence of external factors on the availability of the workers (Grouping variable: Worker category; Test variable: Working hours and shifts on availability)

Ranks			
Test variable	**Worker Category**	**N**	**Mean Rank**
Working hours and shifts on availability (WS_A)	Qualified	67	119.50
	Qualified & Experienced	104	123.21
	Unqualified but Experienced	73	124.24
	Total	244	

Test Statistics	
	WS_A
Chi-Square(**H**)	.219
df	2
Asymp. Sig.(**p**)	.896

The results of the Table 9 above reveal that significant difference is not evidenced in the perceived influence of external factor on the availability of all category workers (H=.219, p >.05). This external factor is perceived to be, more or less, equally important by all the three category workers in influencing their availability, as is evident from the mean ranks of ‘Qualified and Experienced’ workers (123.21), ‘Qualified’ (119.5) and ‘Unqualified but Experienced’ category workers (124.24). However, ‘Unqualified but Experienced’ category workers perceive this factor slightly more important than the other two category workers. ***From the above test, it can be concluded that research hypothesis is rejected.***

7. Conclusions

The paper has highlighted that thee production-worker in most manufacturing SMES is one of the causes of rejections since he holds a *hands-on* role in the conversion process. This is because the components of output level (worker’s effectiveness) – performance, output quality and availability - are influenced by technical, personal and external factors. The factors were identified through literature review and personal interactions with experts from industry and academics. The influence of these factors on the *components* of *output level of workers (overall worker effectiveness)* was examined through developing and testing relevant hypotheses. The test of hypotheses through Kruskall-Wallis statistical test revealed that technical factors are perceived to be important by production-workers in influencing their performance and output quality. However, this perceived importance was found to be different among different category workers. Similarly, the test of hypotheses on personal factors to influence performance, output quality, and availability revealed a significant difference in the perceived importance of different category workers. External factors are perceived to be equally important by all category workers. By addressing the barrier effects of a factor pertaining to the components of output level of a worker (overall worker effectiveness) the output level can be enhanced and the production-workers will be capable of turning Six Sigma level output in terms of quantity and quality.

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