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The Effect of Production Process Management on Quality Control in The Iron and Steel Industry in Libya

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ABSTRACT

Quality is the crucial factor that determines a company's ability to compete in the marketplace and survive. However, developing production process management is one of the most critical factors affecting quality control. Hence, this study aims to investigate the impact of the development of production process management on quality control in the Iron and Steel industry in developing countries. A quantitative approach was utilized to achieve the study's goals. A total of 384 employees working in Libyan Iron and Steel Company were sampled during the data collection stage of this study. Structural Equation Modelling (SEM) was used to evaluate the impact of the development of production process management on quality control. The findings of this study showed a positive and significant impact of the development of production process management on quality control. This study offers practical implications, some recommendations for the direction of future research, as well as study limitations.

INTRODUCTION

Public organizations in developing countries face significant challenges in meeting development needs, especially in unstable countries suffering from economic and political difficulties, such as Libya (Ghumie et al., 2022). These public institutions include the industrial sector, which is considered the foundation of contemporary development in its economic trajectory. It is essential for developing basic infrastructure and is the central pillar on which projects and plans for industrial and civil development, housing, and services depend (Ghumie et al., 2023). In order to achieve comprehensive development and overcome the challenges mentioned above, the industrial sector needs large investments in technology and infrastructure.

Libya is considered one of the most important oil-producing countries in Africa. However, it tries to improve its corporate performance in another sector to reduce its dependence on oil and diversify its sources of national income, such as in other countries. (Alsamawi et al. 2019a; Alsamawi et al. 2019b). Furthermore, Libya has rich deposits of iron ores and is trying to diversify its national sources of income and reduce its dependence on oil. It is therefore investing in the iron and steel industry, which is crucial for meeting local needs in many countries. It is an important resource for creating jobs and improving the living conditions of citizens. Organizations realize that the quality of their product and service is crucial to differentiate themselves from other competitors (Zumrah, 2019; Alrefaei et al., 2019). Ultimately, their market success. organizations that provide a product with high quality will gain a significant competitive advantage (Al-refaei et al, 2023). In the iron and steel industry, quality is the key factor that determines

a company's ability to compete in the marketplace and survive (Godina & Matias, 2018). Consequently, advanced manufacturing technology is one of the areas that industrialized countries in Europe, the United States, and China pay more attention to it (European Commission, 2010; Zhou, 2015) due to the new challenges posed by the advancement of industrial technology and the implementation of intelligent manufacturing. This has progressively accelerated the rate of industrialization and the exportation of industries (Chen et al., 2017, p. 6505). The transformation brought about by intelligent manufacturing will have profound and enduring effects on the future of manufacturing worldwide.

However, Libyan industrial sector can benefit from the wide spread and development of manufacturing technology if it is properly exploited, by carrying out the process of continuous development and modernization of the management of production operations, where quality control in the iron and steel industry can greatly benefit (development of production processes), where quality engineers will be able to discover defects that would not be detectable without cutting-edge technology (Godina & Matias, 2018, P2), and this shift could open doors to the possibility of technological control over quality control, as control allows technology to identify and thus separate each defective piece (Foidl & Felderer, 2016, P6) and thus ensuring high quality for all the production sector, and this will give it a competitive advantage in the local market, as well as in the international market, and earn it a high position, and contribute to supplying the national economy with hard currency, which will return to the Libyan society growth and progress and improve its level of well-being (Belto 2022).

Nevertheless, despite the efforts made by the Libyan Iron

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and Steel Company to develop its products and ensure their quality, such as adopting the company's evaluation and control standards and indicators, including production and quality, performance, efficiency, and others, according to the company's Board of Directors Resolution No. 6 of 2018 regarding adopting performance standards and indicators, the reality is that the company's products are not developed, and their quality is not ensured.. However, the quality of Libyan production still needs to be at the requisite level, and it confronts a significant challenge compared to the same product in established countries (Al-Bayaa, 2020, p. 9).

Despite the company's efforts to prepare appropriate plans to take advantage of opportunities and avoid challenges or reduce their impact in the future, most of the enormous investments made by Libyan iron and steel companies went towards structural dimensions rather than the localization of technology and associated skills. The elements iron and steel This matter quickly enough, as it will inevitably lead to a vicious circle of failure and failure (Al-Jamal, 2018, p. 57), and its inability to manufacture products of the required quality, and this causes it to lose its survival in the competition, leading to a weak contribution to the national economy. Consequently, it failed to accomplish the objective for which it was created.

Libya's iron and steel industry is an essential source of hard currency and support for the national economy, whether by importing iron and steel and receiving payment in hard currency or by exporting iron and steel abroad (Belto, 2022, p. 1). Nonetheless, this sector faces a significant challenge due to the rapid industrial development and high manufacturing quality in some countries and the lacklustre response in Libya, particularly to these industrial developments (Bin Saleh & Al-Rutimi, 2019). As a result, industrial development and the attainment of quality standards in the industry have been greatly disappointing (Al-Bayaa, 2020, p. 9). Therefore, the current study aims to examine the effect of the development of production process management on quality control in Libya's iron and steel industry.

LITERATURE REVIEW

Quality control includes the techniques and activities used to meet quality requirements. Quality control activities can also be categorized into input material quality control, in-process quality control, and product quality control (Wu, & Chen, 2018). The ultimate goal of quality control is to manufacture products economically by minimizing defects in the product and reducing the waste of economic resources. Issues of production economies can be addressed by successfully implementing quality control since quality problems may discourage customers from purchasing manufactured products, which creates pressure to improve product quality through quality control activities (Kim, Lin, & Tseng, 2018). Therefore, Juran (2000) identified basic operations that companies

must carry out to ensure the quality of their products to satisfy their customers. These basic operations are 1) Continuous improvement and development of production processes management. 2) Quality control and control process.

Despite the importance of using advanced technology in the manufacturing process and quality control, researchers have not paid enough attention to this aspect, except for a few studies, such as Drake *et al.* (2021), which focused on studying quality assurance through procedures Standard operating in the health sector, and a study (Dao *et al.*, 2020) that investigated the development of production processes on the performance of mechanical components. In addition, a study (Godina & Matias, 2018) examined the effect of production process management on quality control in the manufacturing sector. Thus, the research lacuna is made evident by the need for prior studies examining the effect of the development of production operations management on quality control. Therefore, the current study examines how developing production process management affects quality control at the Libyan Iron and Steel Company in Misurata.

MATERIALS AND METHODS

This study used a quantitative approach because it enabled the researcher to obtain accurate measurements of the variables and test the hypothesis using data related to the effect of developing production process management on quality control at the Libyan Iron and Steel Company in Misurata. The questionnaire of this study contains 10 items to measure developing production process management and 13 items to measure quality control. Non-probability (purposive sampling) was used in this study. This type of sampling technique was chosen due to the nature of the study, which examines the effect of developing production process management on quality control at the Libyan Iron and Steel Company in Misurata. This technique can achieve the objectives of the study (Malhotra *et al.* 2016). Due to the employees in the developing production processes and quality control departments are the most knowledgeable about the variables of the study. They can answer the survey questions, and their answers will contribute directly to achieving the study's objectives (Sarstedt & Mooi, 2019). While the probability sample technique in which each member of the population (in the iron and steel company) has the same opportunity in the selection process to give information about the study variables may be ineffective in obtaining accurate answers about the study variables. Because it is likely that the respondent (according to the probability sample) works in another department, far from the production and quality control departments, and has sufficient knowledge to answer the questionnaire questions, and therefore his answers may not be helpful or effective in achieving the objectives of the study (Daniel, 2001).

Self-administration technique was used for collecting data

that involves distributing questionnaires to participants to complete the questionnaires on their own. In this investigation, 550 employees from various departments at the Libyan Iron and Steel Company in Misurata were surveyed using this technique. The questionnaire was disseminated specifically to the departments of product development, operations management, and quality control at the Libyan Iron and Steel Company in Misurata. The number of questionnaires reviewed was 406. There are 394 valid responses with a response rate (71.63%). The response rate is acceptable and logical compared to previous studies in Libya, such as Ghumiem *et al.* (2023). The number of completed questionnaires valid for the analysis process in this study was 394.

RESULTS AND DISCUSSION

In this study, the measurement model was evaluated using the Confirmatory Factor Analysis (CFA) method, and AMOS was used for this purpose. The evaluation of the measurement model was conducted in two stages: Firstly, the goodness-of-fit was assessed. Secondly, the construct validity was evaluated by examining both convergent and divergent validity. the structural model was evaluated to determine the significance level of the relationships

between the variables. The critical ratio value was used to determine the significance level of the relationships, with a recommended value of less than 1.96, as suggested by Byrne (2016).

Demographic Profile of Respondents

Table 1 showed the demographic and profile details of the respondents; the total sample of the study was 394 employees from the Libyan Iron and Steel Company in Misurata. In terms of age, 2.0 % (N= 8) of the respondents were below 30 years old, while 23.4 % (N=92) were between 30-40 years old; 33.5 % (N= 132) were between 41-50 years old, and 41.1 % (N=162) were above 50 years old. Regarding the qualification, 22.3 % (N= 88) of them hold secondary school, 32.0 % (N= 126) of them hold a diploma, 41.6 % (N= 164) of them hold a bachelor's degree, and 4.1 % (N=16) of them hold a master's degree. In terms of working experience, 1.8 % (N= 7) of them have been in the company for less than 5 years, 7.9 % (N= 31) of them have been in the company between 5-10 years, 15.5 % (N= 61) have been working between 11-15 years, 74.8 % (N= 295) have been working for more than 15 years. Table 1. Demographic profiles of the respondents.

Table 1: Demographic and Profile Details of Response

Characteristics	Category (years)	Frequency	Percent
Age	below 30 years	6	2.0
	30 – 40	92	23.4
	41 – 50	132	33.5
	> 50	164	41.1
Qualification	Secondary School	88	22.3
	Diploma	126	32.0
	Bachelor's degree	164	41.6
	Master's degree	16	4.1
Working experience	< 5 years	7	1.8
	5-10 Years	31	7.9
	11-15Years	61	15.5
	> 15 Years	295	74.8

Assessment of Measurement Model

Two latent variables (developing production process management and quality control) include the measurement model. Estimates of factor loadings for all items included in the model exceeded the endorsed amount, ranging from 0.69 to 0.78 for developing production process management and 0.68 to 0.86 for quality control (refer to Table 2). The CFA results for the measurement model depicted in Figure 1 revealed a satisfactory model fit for the following metrics: χ^2 statistic = 524.442, $p < 0.000$, $df = 227$, $CMINDF = 2.31$, $TLI = 0.95$, $CFI = 0.95$, $RMSEA = 0.058$ (Hair *et al.* 2019); These metrics are adequate for evaluating model fitness (Kline, 2016; Zumrah *et al.*, 2021).

The reliability and validity of the current model were determined by calculating Cronbach's Alpha and composite reliability (C.R.) of the constructs. On the other hand, the factor loadings for each item were assessed to determine the convergent validity (CV) of the models; the average extracted variance (AVE) was also calculated. According to Table 2, the results of reliability and convergent validity provided acceptable indicators. Discriminant validity (DV) measures the extent of variation between different variables. Fornell Larcker Criterion (FLC) is commonly used to evaluate discriminant validity (Al-refaei, Zumrah, &, Al-Shuhumi, 2019). FLC necessitates that the value of the AVE square root coefficients existed in the correlation matrix be

Table 2: Reliability, indicators' factor loading, and constructs' validity

Construct and Indicators	Loading	Alpha	CR	AVE
Production Process Management				
PP1	0.74	0.92	0.92	0.54
PP2	0.76			
PP3	0.73			
PP4	0.72			
PP5	0.73			
PP6	0.70			
PP7	0.78			
PP8	0.72			
PP9	0.69			
PP10	0.78			
Quality Control				
QC1	0.70	0.96	0.95	0.64
QC2	0.82			
QC3	0.70			
QC4	0.86			
QC5	0.83			
QC6	0.76			
QC7	0.84			
QC8	0.86			
QC9	0.75			
QC10	0.85			
QC11	0.84			
QC12	0.68			
QC13	0.84			

Table 3: FLC of all the constructs

Variables	Production Process Management	Quality Control
Production Process Management	0.74	
Quality Control	0.706***	0.80

larger than the value of squared correlation estimates of the construct. (Fornell & Larcker, 1981).

The findings of the CFA showed factor loadings ranged between 0.68 and 0.86. Cronbach's Alpha for developing production process management was 0.92 and for quality control was 0.95. The C.R. for each construct had satisfying values; for developing production process management, it was 0.92; for quality control, it was 0.96; these values were above the specified cut-off value of 0.70. (Hair *et al.*, 2019). In contrast, the AVE value for each construct ranged from 0.54 to 0.64, which was more than 0.50 and lower than the C.R. value predicted by Hair *et al.* (2019). thereby establishing the convergent validity (CV) of the measurement model.

Discriminant validity (DV) which was evaluated by

the Fornell Larcker Criterion (FLC) demonstrated greater values of the AVE square root coefficient in the correlation matrix compared to that of the constructs' squared correlation estimates (Fornell & Larcker, 1981).

Structural Model

The structural equation model of the current study figure 1, evaluates the direct impact of developing production process management on quality control. Model fit indices for the structural model indicate a reasonable fit (see Figure 1) with the following metrics: χ^2 statistics = 524.442, df = 227, CMINDF = 2.31, p 0.0001, CFI = 0.95, TLI = 0.95, RMSEA = 0.058. these metrics demonstrated a reasonable model fit for this model using these metrics as suggested by Hair *et al.* (2019).

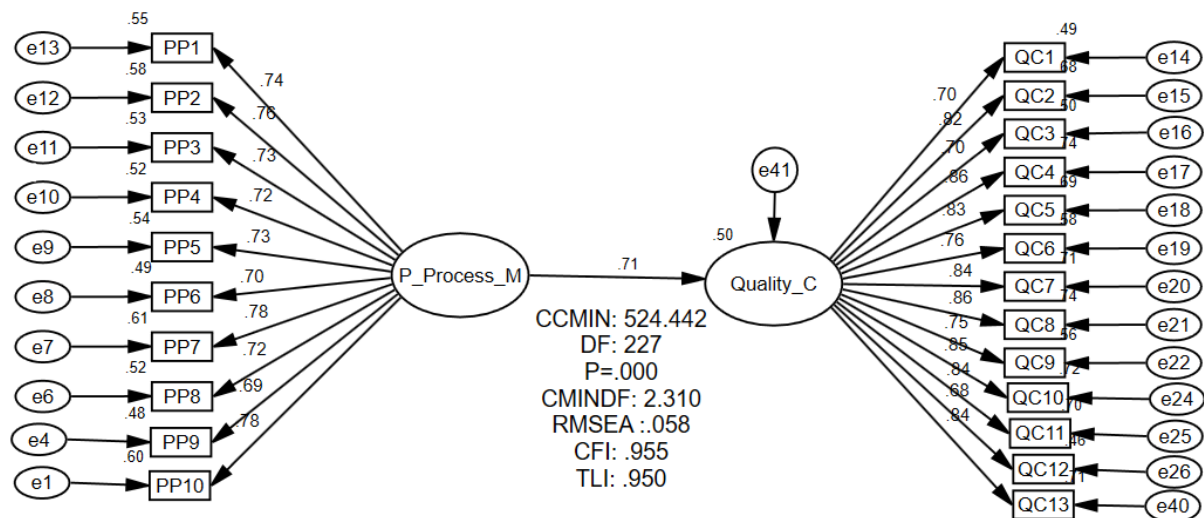


Figure 1: Structural Model of the study

Hypothesis Testing and Results

The result structural model emphasizes the significance of the relationship between developing production process management and quality control, as presented in Table 4. According to Byrne (2016), the t-statistic must be greater than 1.96, and the p-value must be less than

0.05. For the influence of developing production process management on quality control, the standardized path coefficients were positive and statistically significant ($\beta = 0.71$, $t = 11.56$, $p = 0.000$). Table 4 also displays the result of the standardized regression estimation for the structural model.

Table 4: Standardized Regression Estimation

Path	Estimate		Standard Error	t-value (C.R)	p-value	Result
	USD	SD				
Culture → Performance	0.70	0.71	0.061	11.56	0.000	Supported

*Note: USD= Unstandardized. SD= Standardised

CONCLUSIONS

According to the result of this study, there is a direct effect of the development of production process management and quality control from the perspective of the study sample at the Libyan Iron and Steel Company in Misurata, and statistical analysis confirmed this relationship. This result demonstrates the interest of the Libyan Iron and Steel Company - Misurata in the continuous development of the management of production processes throughout the various stages of manufacturing, beginning with the detection and auditing of production processes, melting and casting raw materials in the rods and skewers section of the steel plant, and concluding with the examination of finished products. All of these procedures improve the quality of the final product. The study shows a direct relationship between developing production process management and quality control at the Libyan Iron and Steel Company Misurata.

On the contrary, the lack of interest in the continuous development of the management of production operations by the management of the Libyan Iron and Steel Company - Misurata will fail to control the product's quality, resulting in the company's inability to compete in the market and a decline in its market share. This interpretation is consistent with theorists and experts of quality programs, as numerous studies (Williams *et al.*,

2006; Oakland & Tanner, 2007; Asif *et al.*, 2009) have shown that failures associated with the failure of quality management programs are pervasive. Moreover, one of the most important reasons for this is the weakness in the planning of production processes and quality management systems, as well as their inability to learn, adapt to change, and predict the future, due to the fact that the management of operations, the implementation, and the success of quality programs require a great deal of effort and resources (Asif *et al.*, 2009). Therefore, the researcher believes that the continuous development of the management of production processes and the ability to adapt them to emergency changes will spare the Libyan Iron and Steel Company many problems and tighten its control over the quality of its products, as any problem in the production processes will have a direct impact on product quality.

The result of this study is consistent with the principles of the theory of comprehensive quality management, which were developed by the first theorists of quality, such as Edward Deming (1986), Juran (1993), Ishikawa (1986), and others, and which emphasize the use of a set of methods, techniques, and administrative practices within an organization to improve quality, as well as quality control and monitoring, with the primary objective of meeting customer expectations by enhancing quality. The

result of this study is consistent with the “hard” total quality management practices identified by (Wilkinson, 1992), and these solid practices emphasize developing production techniques, such as controlling production processes, sharing the quality function, designing processes for products, and monitoring Inventory, timely supply and handling of materials, as well as focusing on these practices and continuous development and control of production processes. Researchers in the field of total quality management, such as (Feng *et al.*, 2006; Sutrisno, 2019; Youssef & Youssef, 2018), developed a set of indicators to measure operational performance, including the following: enhancing product quality, service quality, increasing productivity, and decreasing waste costs and reducing waiting time, delivering products accurately, and optimizing inventory performance. This study concludes that if the Libyan Iron and Steel Company adheres to these indicators and works to improve and develop them perpetually, it will maintain product quality, thereby gaining a competitive advantage and surviving in the market.

Implications of the Study

This study is considered one of the few and scarce studies that provide, through the practical study on the Libyan Iron and Steel Company - Misurata, practical evidence of the most important factors that work to improve the final product of the company, leading to the desired quality control that gives Libyan production a tremendous competitive advantage. The practical contributions of the current study are to assist the managers in the process of quality control at the Libyan Iron and Steel Company - Misurata and provide them with a practical guide to benefit from strategic plans based on accurate information through the development of production operations management and to utilize these plans for the continuous improvement of product quality, up to the required quality and control. Through the continuous development of production processes, strategic planning, and quality control, the quality management and control process is not distinct from the rest of the company's sequential processes but forms a continuous link with them. Quality control cannot be attained without continuous improvement of the company's production processes.

Limitations and Direction for Future Research

This study relied on the cross-sectional method in the data collection process, as the study data were collected in a specific period. This study believes that it is helpful to conduct a similar study based on data collection in two separate periods, such as collecting data before and after the development of the production management process and comparing the results in the quality control process, in order to reach the actual impact of the development process in the production processes. This study was conducted in one company, the Libyan Iron and Steel Company - Misurata. It is helpful to conduct similar studies on more than one company, whether in the same sector or to repeat the same study on companies in

other sectors, to obtain more comprehensive results and research that can be generalized to other sectors

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