Quality-Oriented Preventive Maintenance Practices and Performance among Malaysian SMEs Manufacturing Organizations: Findings from a Survey

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***Abstract*— Maintenance has become an important aspect in the manufacturing environment. There are a number of new technology and advancement in the manufacturing industry which can improve daily operations and production. In order to ensure smooth daily operations, the aspect of maintenance must be given a priority. A quality-oriented preventive maintenance practices such as preventive maintenance team, preventive maintenance strategy and planned maintenance can help to avoid any potential stoppages and disruptions of equipment from occurring in their daily operations. Preventive maintenance (PM), utilises total employee involvement in the maintenance activities. Operators and all employees should be actively involved in a maintenance programme that enable to avoid any disruptions, breakdowns, stoppages, failures, and so forth in order to improve manufacturing performance. Therefore, in the highly competitive manufacturing industries, the ability and reliability of equipment that well-maintained is very important in order to achieve desired performance. Furthermore, several studies in the literature argue that further research is required in the area of maintenance and operations management. This study investigates the extent of PM practices in the Malaysian Small and Medium Enterprises manufacturing organizations and to investigate the relationship between PM practices and performance. The hypotheses were analysed using Smart PLS and some important findings were discussed. The results imply that PM practices significantly improved manufacturing performance. For instance, PM strategy was positively and significantly related to financial, innovation and organizational capabilities. However, there were few research insignificant findings found for example planned maintenance is insignificant with innovation. Furthermore, the contributions and limitations of the study also discussed accordingly.**

Keywords*—Preventive, Maintenance, SMEs, Performance, Manufacturing*

1. Introduction

Improvements in technology coupled with globalisation have propelled manufacturing companies to change fast and be able to suit customers' demands at all times. In manufacturing companies the pressure to ensure equipment operates without breakdowns, stoppages, failures and so forth has become a major concern for maintenance staff [1] .Disruptions and breakdowns of equipment certainly affect the achieving of this, and can be considered to be a precarious maintenance issues.

The environment of maintenance work has changed significantly in recent years, especially in manufacturing companies. Indeed, Moubray (1997) argues that this is due to the increasing number and variety of physical assets that need to be maintained [2]. Increasing automation and its complexity; new maintenance techniques and changing views on maintenance organisation and responsibilities are also important factors affecting the maintenance work environment. Misconceptions on maintenance being viewed as operational expenses to be minimised instead of the investment to improve the process capability should be remedied due to the manufacturing excellence performance if maintenance is well

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implemented in an organization. Maintenance has now become a strategic tool to increase competitiveness rather than simply an overhead expense that must be controlled [3]. Investment in maintenance, one of the basic functions of a firm, returns improved quality, safety, dependability, flexibility and lead times [4]. Therefore, it is very important to ensure proper maintenance strategy to ensure equipment deteriorations, failures, stoppages, and breakdowns can be reduced through total participation of all employees. Nahas (2017) illustrated that optimal preventive maintenance policy and the optimal buffer allocation that will minimize the total system cost subject to a given system throughput level [5]. Many companies rely so much on the technical and engineering staff to look after the equipment condition. Preventive maintenance (PM) illustrates the potential of ordinary production floor to assist the technical staff in maintaining equipment and machineries. Potentially, improved manufacturing performance such as quality, cost reduction, delivery and flexibility can be gained through undisrupted operations [6].

2. Literature review

Performance is a measuring tool that helps us to understand what are the current status about our products, services, and the processes that help us to take an necessary action and intelligent decisions on understand, manage, and improve in the organizations [7], [8]. On other hand [9], [10] have confirmed that the performance has the capable to measure both financial and non-financial improvement in lean environment. In a study did by Withidyothin (2014) to identify whether the performance of a machine affects production capacity, at the final outcome he declare that firm's has a same production capacity with the existing machine which is an important part of a supply chain network [11].

After review of various study the researchers found that most scholars and companies are use the performance to measure on costs, quality, quantity, cycle time, efficiency, productivity of products, services, and processes as long as ways to measure those things have existed. To address this matter Goold and Quinn (1991) argued that performance help to evaluate the effectiveness on the speed of change and the measurability of performance [12]. In addition [13], [14] state that performance is a process of measurements for a specific process of stimulate ideas and reinforce the notion [Many scholars were found that by implementing performance measurement was lead to substantial benefit which helps to understand overall performance in organization [14-16].

[17], [18] stated that performance measurement was used in quantify the efficiency and effectiveness in order to improve the productivity on other hand [17] classified performance measurement into four it was cost, time, flexibility and quality [18]. However there were only two indicators that mainly used in make decision it was cost and non-cost. The cost was purposely used to measures strategic decision meanwhile non-cost was measures vital effect of day-to-day operation. However Tangen (2003) state that cost measures are the most popular measurement which used to indicate business performance [19].

Preventive maintenance (PM) is a regular and systematic inspection, cleaning, and replacement of worn parts, materials, and systems. Preventive maintenance helps to prevent failure of parts, materials, and systems by ensuring that they are in good working order. A preventive maintenance plan is developed based on the needs of the equipment.

In PM, the system which is highly likely to exhibit a demobilising fault is replaced before that failure is allowed to occur. The most common forms of this policy are scheduled PM and condition-based maintenance (CBM) [20]. In the former approach, the PM action is performed on the item at a scheduled time regardless of its actual condition. However, a scheduled PM policy some components may be over maintained that is replaced prematurely. Thus, if the condition of the item can be monitored continuously or even frequently, PM actions will be implemented only when failure is judged to be imminent. This is the basic concept of CBM. Performance-parameter analysis, vibration monitoring, thermography, oil analysis or ferrography are some condition-monitoring techniques that are involved in CBM. Each of these methods will reveal a specific type of fault.

Qualified and well-trained machine operators and maintenance technicians are the driving force behind any effective maintenance measurement system. They collect the information (especially in small extent automated factories with no automatic data collection), and they report occurrences [21]. Most of the maintenance tasks are handled directly by operators instead of the on-site maintenance team. Thus, flexible, co-operative and a shared responsibility approach among production and maintenance personnel is required to promote operator ownership and free up maintenance personnel to perform more technically challenging maintenance works [22]. The human factor represented by maintenance technicians and other related staff is the backbone of the maintenance system in any organization.

As such, the effectiveness of the different facets of the performance system is very much dependent on the competency, training, and motivation of the overall human factor in charge of the maintenance system [23]. In this context, factors such as, years of relevant work experience on a specific machine, personal disposition, operator reliability, work environment, motivational management, training and continuing education, are all relevant factors which tend to impact the effectiveness of the performance of the maintenance system [24]. Operators are in direct contact with the maintenance activities and efforts. Therefore, they are able to judge the quality of the service they receive. In this context, their regular feedback should be incorporated into the evaluation of the maintenance system. The close cooperation and coordination between the maintenance technicians and machine operators is very critical, as it influences service quality and, in turn, the extent of satisfaction with the rendered services. In this context, repeated visits to repair equipment for the same problem result in operator dissatisfaction [25]. As in all quality oriented management programmes, employee participation is critical for success.

The attitude, conduct and personality of maintenance personnel are critical to the effectiveness of the maintenance effort [26], [27]. The human resources aspect of maintenance has been playing an increasing role in relation to operational environment safety [28], [29]. Maintenance resource management addresses the issues related to organization, communication, problem solving, and decision making [30]. Maintenance and safety, are sometimes, treated as separate and independent sets of [31]. However, part of the accidents in manufacturing environments is caused by poor maintenance [31]. An integrated approach is the appropriate approach for optimizing plant capacity, as safety and maintenance are not mutually exclusive functions [31], [32]. If an organization stresses teamwork, the remuneration structure should promote cooperation rather than undermine it [33].

A wide variety of remuneration programmes, which take into account factors, other than rank, experience and length-of-service exist. These programmes are been used in modern, innovative organizations. Some organizations use pay-for-skill programmes to develop multi-skilled employees, pay-for-performance, promote goal-sharing programmes, and provide bonuses that are linked to group performance [33], [34], [20]. However, offering the right rewards alone is unlikely to 16 produce sustained empowerment. The power of such methods to maintain commitment declines with use [20]. Involvement and autonomy are the main motivations that activate the human mind and drive human effort [20].

Mechanical, process or control equipment failure can have adverse results in both human and economic terms. In addition to down time and the costs involved to repair and/or replace equipment parts or components, there is the risk of injury to operators, and of acute exposures to chemical and/ or physical agents. Preventive maintenance, therefore, is a very important ongoing accident prevention activity, which you should integrate into your operations/ product manufacturing process. Furthermore, to be competitive on both a national and a global basis, organizations must adopt a forward-thinking approach in developing their preventive maintenance management strategies. Maintenance strategy will help an organization to better control its processes and also provide a guidance how the quality of end product. Applying excellence maintenance strategies will not only support and sustain quality and productivity, but also become a drive for continuously improving the effectiveness of organization operation. Producing good quality product gives competitive advantages to the organization. Thus, to be effective preventive maintenance activities, organization should applied a good preventive maintenance strategy.

Fredriksson and Larsson (2012) defines maintenance strategy as “the management method used in order to achieve the maintenance objectives” [35]. According to Bergman and Klefsjo (1994), the content in the maintenance strategy is a mix of techniques and/or policies which depends on factors such as the nature of the plant, the maintenance goals or the equipment that will be maintained, the work environment and the work flow patterns [36]. Rastegari and Salonen (2013), states that “the strategy reflects the organizations conception of its intended long – term goal and the approach to achieve it” [37]. Maintenance strategies are a means of transforming business priorities into maintenance priorities [38].

Study by [39] indicate the importance of preventive maintenance strategy as one of the essential elements in lean manufacturing best practices. Maintenance strategy is defined as a decisions rule which establishes the sequel of maintenance action. Each maintenance action allows one to maintain or restore the system in a specified state by using the appropriate resources [40]. According to Swanson (2011), there are three maintenance strategies. Figure 1 depicts the maintenance strategies [41].

Planned Maintenance has two loops: Planning, scheduling, Execution and Follow up make up the first loop while second loop consists of work identification and performance analysis elements. Planned maintenance process is measured by schedule compliance i.e. the percentage of work orders completed during the scheduled period before the late finish or required by date. World class maintenance should achieve more than 90% during execution. Effective maintenance will extends equipment life, improves equipment availability and retains equipment in proper condition without delay of production schedules [42].The aim of the planned maintenance is to allow equipment operators and maintenance engineers to analyse the cause of equipment failures and develop a planned maintenance system to repair or modify the equipment to improve maintainability and planned maintenance typically involves the work conducted by skilled maintenance engineers, but the aim is to transfer the tasks to the equipment [43].

There are various concepts associated with effectiveness of maintenance activities has been developed, but the two common concepts discussed in literature as, Reliability Centered Maintenance (RCM) and Total Productive Maintenance (TPM) [37]. TPM was established to maximize equipment effectiveness or improving overall efficiency through a comprehensive productive-maintenance system covering the entire life of the equipment, spanning all equipment related fields and the participation of all employees from all levels, to promote productive maintenance through motivation management or voluntary small-group activities [44]. Meanwhile Reliability Centered Maintenance is the process of determining the most effective maintenance approach. It is developed to ensure that systems continue to do what their users require in their present operating context and generally used to achieve improvements in fields such as the establishment of safe minimum levels of maintenance. Successful implementation of RCM will lead to increase in cost effectiveness, reliability, machine uptime, and a greater understanding of the level of risk that the organization is managing. Rastegari and Salonen (2013), defines RCM as a process used to determine what must be done to ensure that any physical asset continues to do what its user wants it to do in its present operating context [37]. RCM focuses on understanding and identifying system functions, functional failures and the consequences of those failures [45].

According to Muyengwa and Marowa (2015) TPM can improve dimensions of cost, quality, and delivery and it can be a strong contributor to the strength of the organization [46]. In essence TPM is an approach which seeks to develop maintenance practices through a combination of measurement, planning, training, and the active involvement of a broader range of employees in addition to maintenance personnel in maintenance related activities [47]. Takada et al. (2017) suggest the error prediction system that enable employees to operate preventive maintenance function on a real time basis [48].

In today's highly competitive environments, costs reduction is one of the most important issues in the majority of manufacturing industries. The ability of manufacturers to sustain depend its ability to provide customers with lean services and life-cycle costs for sustainable values at all times [49]. Machine failures are considered as the main target of the cost reduction in maintenance engineering departments [50]. Industry today is forced to increase production efficiency continuously in order to be competitive. The maintenance of production equipment is one important factor of this. Maintenance in its narrow meaning includes all activities related to maintaining a certain level of availability and reliability of the system and its components and its ability to perform to a standard level of quality. It includes activities related to maintaining spare part inventory, human resources and risk management [44]. According to Industrial Accidents Preventive Association-IAPA (2007), preventive maintenance is predetermined work performed to a schedule with the aim of preventing the wear and tear or sudden failure of equipment components [51]. Preventive maintenance helps to (i) protect assets and prolong the useful life of production equipment (ii) improve system reliability (iii) decrease cost of replacement (iv) reduce system downtime, and (v) reduce injury.

3. Methodology

This study employed a cross-sectional approach in order to examine the extent of PM practices and to study the relationship of PM practices and performance among SMEs in Malaysia. Pilot study was also done in order to get some important information about the understanding of potential respondents. The sampling technique utilized for the present study is simple random sampling. A total of more than 250 self-administered questionnaires were distributed through enumerators to respondents who were managers of quality, operations, plants, engineering and those who were familiar with PM in the SMEs. This study was conducted in a non-contrived setting following Sekaran (2003) who states that: 'correlational studies are always conducted in the non-contrived setting' (p.204) [52]. As an effort to increase the response rate the study increased its amount of questionnaire sent and personal telephone calls were made to the respective respondents to participate in this study by the enumerators. The research team also sent out reminder notes to the respondents reminding them to participate in the present study. Some field trips were made and notes were taken based on observations to strengthen the discussion of the results obtained. This helps to explain certain phenomenon better and ascertain the findings. The quantitative based study very much depends on the representativeness of the samples therefore sampling was done with caution. The population of this study was drawn from the manufacturing companies registered under the Federation of Malaysian Manufacturers' (FMM) Directory 2014. There are more than 3752 companies registered under FMM (FMM, 2014). The sampling procedure for this research is based on the sampling frame of manufacturing companies in the FMM (2014) directory and the number of SMEs were decided using the total of permanent staff in that particular organization. For instance, SME Corporation (2013) has given definition of SMEs in manufacturing sector, sales turnover not exceeding RM50 million OR full-time employees not exceeding 200 workers.

The respondents of this study were maintenance, productions, operations and quality managers as well as persons who were able to provide answers to questions on PM related practices and performance. Brah and Chong (2004) state that operations and quality management managers are the most appropriate individuals to provide maintenance related information, especially PM or total productive maintenance [53]. The unit of analysis for this study was an organization because the target respondents were capable of providing data related to the SMEs that involved in manufacturing and performance of their companies.

4. Data analysis

The data for the study variables were obtained through student enumerators who were postgraduate students in various classes. This approach of getting the postgraduate student enumerators facilitated higher chances of questionnaire retrieval. This effort yielded in a return of 142 questionnaires for analysis out of the 250 questionnaires being distributed which resulted

In 56.8% response rate. Out of the 142 retrieved questionnaires, nineteen were not usable due to poorly fill and did not have adequate data suitable for further processing. According to [54], [55] these questionnaires can be discarded. The final 123 responses were used for further analysis which resulted in 49.2% response rate for final analysis. This rate is considered adequate because it agrees with some underlying assumptions for data analysis. Firstly, the total number of usable questionnaire agrees with [56] suggestion that for a regression type analysis, the sample size should fall between five and ten times the number of independent variables. However, [57],[58] opined that the more conservative figure of ten is preferred in order to avoid over fitting. Secondly, for the Partial Least Squares (PLS) program that is to be used for the main analysis, Chin and Newsted (1999) suggested a minimal number of between 30 and 100 cases [59]. Therefore, this sample size is good for further analysis.

A. Status	B. Number of Questionnaire s	C. Response Rate
D. Distri buted	E. 250	F. 100.00%
G. Retur ned	H. 142	I. 56.8%
J. Usable	K. 123	L. 49.2%

Soon after the raw data has been entered in the SPSS the process of data screening and cleaning/treatment is required. This involves checking for errors in the data collected [60]. These errors take the form of missing data or out of range data (values that fall outside the range of possible values for a scale). It was therefore important for the researcher to check on these and handle them accordingly. According to Pirker (2009), it is recommended to handle missing values with imputation by replacing missing values using the remaining values of the data. To obtain accurate model specifications, the mean can be used for the imputation [52]. Using the mean to replace missing values also leads to more reliable results than casewise deletion [54]. This is because in for pre-processed data that is intended to be exported to the PLS path modelling software, casewise deletion will throw away a lot of useful information, which will in turn lead to lower efficiency, and thus not recommended [62]. Based on this recommendation, a few cases of missing values which were identified were replaced accordingly using the mean values of the items. This was done as the number of missing values did not pose any statistical threat to the analysis phase of this study. In addition to the above treatment, tests on normality was not done because the PLS is a distribution-free approach. It also uses the usual maximum likelihood estimation method, which assumes multivariate normality [63]. Since the PLS factors are orthogonal, the issue of multicollinearity is not a problem. Factorial validity is another important in the context of establishing the validity of latent constructs [64]. Validity is a test of how well an instrument that is developed measures the particular concept it intended to measure [65]. According to [66] two elements of factorial validity can and must be measured when using PLS for data analysis. These two elements are convergent validity and discriminant validity, which [67] described as components of a larger scientific measurement concept known as construct validity. Construct validity affirms to how well the results gotten from the use of the measure fit the theories around which the test is designed [65]. The issue to be addressed here is if the instrument explains or has a strong connection with the concepts as theorized. The researcher examined the factor loadings and cross loadings in table 4.5 to ascertain if there are problems with any particular items. A cut off value of 0.5 (being significant) as suggested by was used in this regard [68]. In view of this, if any items which has a loading of higher than 0.5 on two or more factor, then they will be deemed to be having significant cross loadings [68]. Therefore, based on table 4.5, it is concluded that construct validity is confirmed. The next analysis done by the researchers was to test the convergent validity. This is the degree to which multiple items measuring the same concept are in agreement. As suggested by [68], the factors loadings, composite reliability and average variance extracted was used to assess convergent validity. Based on the presentation in table 4.4 and table 4.5, the loadings converge very well and exceed the recommended 0.5 value as recommended by [68]. Also, the composite reliability (CR) values in table 4.4 which ranged from 0.861 to 0.908 exceeded the recommended value of 0.707 by [68], [69]. Also the average variance extracted (AVE) which measures the variance captured by the indicators relative to measurement error, which should be 0.50 Barclay, [70]. From table 4.4 the AVE was in the range of 0.663 to 0.792.

The researchers proceeded with testing the discriminant validity of the constructs. This was done by assessing the correlations between the measures of potentially overlapping constructs and the average variance extracted for each construct should be greater than the squares of the correlations between the construct and all other constructs [71]. Compeau, Higgins, & Huff (1999) also noted that items should load more strongly on their own constructs in the model, and the average variance shared between each construct and its measures should be greater than the variance shared between the construct and other constructs [72].

Hypothesis 1, 2 and 3 respectively postulated that there would be a relationship between planned maintenance to manufacturing performance namely financial, innovation and organizational capabilities. As the results in Table 4.6 indicate planned maintenance is related to both financial ($\beta = -0.219$, $p > 0.01$) and organizational capabilities ($\beta = 0.152$, $p > 0.05$) however planned maintenance is not related to innovation. Thus hypothesis 1 and 3 were supported while hypothesis 2 was rejected. On a similar vein hypothesis 4, 5 and 6 postulated that there would be a relationship between planned maintenance strategy and manufacturing performance namely financial, innovation and organizational capabilities. The results indicate that planned maintenance strategy is only related to innovation ($\beta = 0.181$, $p > 0.05$) and not related to financial and organizational capabilities. As such hypothesis 5 is supported while hypothesis 4 and 6 was rejected. While hypothesis 7, 8 and 9 postulated that planned maintenance teams would be related to manufacturing performance namely financial, innovation and organizational capabilities. The result indicated that planned maintenance team is related to both financial ($\beta = 0.173$, $p > 0.05$) and organizational capabilities ($\beta = -0.153$, $p > 0.05$) however planned maintenance team is not related to innovation. Thus hypothesis 7 and 8 was supported and hypothesis 9 was rejected.

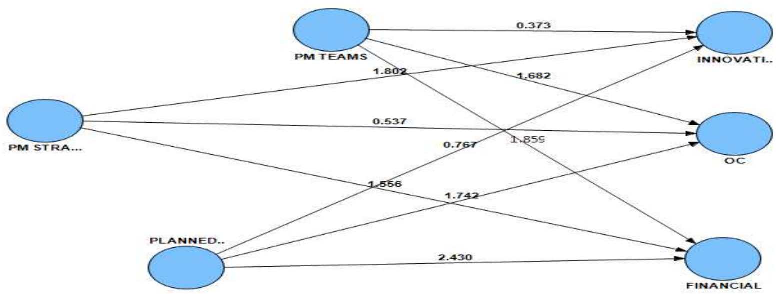
Description of Samples	Number	Percentage
Size of Companies		
Small	15	12.20
Medium	108	87.80
Types of Industries		
Electrical and Electronics	20	16.26
Automotive	96	78.05
Rubber based and Plastics	7	5.69
Years of Operations		
Below 10 years	101	82.1
More than 10 years	22	17.9
Type of Companies		
Local Owned	68	55.28
Joint Venture	55	44.72

Construct	Item	Loadings/ Weight	AVE[a]	CR[b]
Financial	FINANCIAL1	0.827	0.736	0.893
	FINANCIAL3	0.856		
	FINANCIAL5	0.890		
Innovation	INNO3	0.746	0.674	0.861
	INNO4	0.886		
	INNO6	0.825		
OC	OC1	0.892	0.732	0.891
	OC3	0.828		
	OC4	0.846		
Planned Maintenance	PLANNEDMAINTENANCE1	0.834	0.683	0.895
	PLANNEDMAINTENANCE2	0.901		
	PLANNEDMAINTENANCE3	0.848		
	PLANNEDMAINTENANCE7	0.711		
PM Strategy	PMSTRATEGY10	0.865	0.792	0.884
	PMSTRATEGY9	0.914		
PM Team	PMTEAM2	0.766	0.663	0.908
	PMTEAM5	0.855		
	PMTEAM6	0.795		
	PMTEAM7	0.751		
	PMTEAM9	0.896		

	FINANCIAL	INNOVATION	OC	PM	PM STRATEGY	PM TEAMS
FINANCIAL	**0.858**					
INNOVATION	-0.079	**0.821**				
OC	-0.056	-0.151	**0.856**			
PM	-0.207	-0.090	0.143	**0.826**		
PM STRATEGY	-0.139	0.182	0.054	-0.014	**0.890**	
PM TEAMS	0.162	-0.048	-0.145	0.054	-0.001	**0.815**

Hypothesis	Relationship	Beta	Standard Error	T-Value	Decision
H1	**PLANNED MAINTENANCE -> FINANCIAL**	-0.219	0.090	2.430**	**Supported**
H2	**PLANNED MAINTENANCE -> INNOVATION**	-0.085	0.111	0.767	**Not Supported**
H3	**PLANNED MAINTENANCE -> OC**	0.152	0.087	1.742*	**Supported**

H4	**PM STRATEGY -> FINANCIAL**	-0.142	0.091	1.556	**Not Supported**
H5	**PM STRATEGY -> INNOVATION**	0.181	0.100	1.802*	**Supported**
H6	**PM STRATEGY -> OC**	0.056	0.105	0.537	**Not Supported**
H7	**PM TEAMS -> FINANCIAL**	0.173	0.093	1.859*	**Supported**
H8	**PM TEAMS -> INNOVATION**	-0.043	0.115	0.373	**Not Supported**
H9	**PM TEAMS -> OC**	-0.153	0.091	1.682*	**Supported**



5. DISCUSSION AND CONCLUSION

It is certainly essential for manufacturing companies to properly plan such activities due to the stiff challenges of the manufacturing environment. The pressures of uncertainty in the market place, customer needs and so forth reflect that fast actions must be taken. On the other hand, PM strategy needs strong support from top management and all levels of employees. It is very important to ensure the various parties in the organisation are sharing the same goals and visions.

PM strategy is rooted in the definition of PM itself and focuses on overall equipment effectiveness, continuous improvement activities to prevent equipment deterioration, total employee participation, teamwork and small group philosophy [21] as well as safety and environmental issues [73]. The focus on PM strategy is an obvious benefit and has become the main priority among the participating manufacturing companies. It is essential to draw up a systematic and thorough strategic plan to ensure more opportunity for improvements.

Low PM team usage can hinder PM objectives from being achieved. More importantly, as [74] outlines, a PM team development plan is needed in order to ensure all PM teams can contribute significantly to performance improvement, especially regarding elimination of equipment related losses and defects. It is also possible that this low implementation of PM team is due to a lack of exposure to resource-based knowledge among the Malaysian manufacturing companies. The fact that most companies still apply the concept of firefighting to maintenance and employ reactive approaches towards maintenance demands addressing. The maintenance staff are waiting for breakdowns and for equipment failures rather than studying the current equipment to improve its condition and avoid deterioration. The highly competitive global business scenario, manufacturers are constantly focussing on the quality of the products, cost of production and delivery status. On the other hand, manufacturers are also giving more attention to the losses that are related to quality rather than equipment-related losses or defects [75]. PM tries to ensure equipment related losses are minimised and more effort is made to reduce equipment-related losses or defects. PM could essentially help to minimise the deterioration of equipment, hence improving performance as highlighted by various researchers, for instance [75-77]7].

The results indicate that most of the manufacturing companies are implementing PM practices which put more focus on ensuring the equipment health status. Operators with direct involvement in daily operation of equipment have been exposed to doing some basic cleaning, lubricating, topping up of fluids and monitoring of abnormalities and so forth and all these related to PM activities. The maintenance possibly worked as a separate function, thus not cooperating with other departments as well. This problem may be a direct result of when maintenance is seen as a reactive rather than proactive activity. The dynamic business pressure and current competitive trends have been setting maintenance more challenges.

PM teams are led by a manufacturing manager and also include maintenance managers, workshop delegates, quality department delegates, manufacturing delegates, and technician or maintenance service. In addition, the role of a PM team is very big and includes responsibility for overall equipment effectiveness analysis, six big losses analysis and finding solutions to problems. The present study shows findings inconsistent with [78]. Contrary to expectations, this study has not found a significant relationship between PM team and innovation. However, this study found that there were significant relationships between PM team and financial; and PM teams and organizational capabilities. The possibility of PM teams might not be efficient enough to contribute to innovation due to the PM team usage in the SMEs lack of substantial fund to ensure team effectiveness.

As noted by Chan et al. (2005) based on their case study, work habits and communication especially for production lines and different shifts could affect the morale of PM team development [79]. The possible assumptions to be drawn from this study are that the communication and leadership of PM team are not clearly perceived by those at operator level and other departments. The PM team has been perceived as unable to formulate actions that can effectively help to reduce costs, to increase quality, improve delivery reliability and improve human and equipment flexibility as well.

The effectiveness of communication in a production line is very important. Not only among production line staff, open and clear communication with other supporting staff related to the production line such as maintenance technicians, quality control staff, material control and parts quality control staff also would be able to bring togetherness and increased working spirit. Although cost is one of the most important indicators of manufacturing performance, the relationship between PM team and cost showed insignificant correlation.

PM team leadership is also very important in PM implementation. The role of PM team leadership to clearly deliver the important message of what the main goals and objectives of PM are in relation to the organization’s overall goals is crucial. Inability of the leadership of a PM team to demonstrate clear vision and the overall mission of their organizations can affect performance in long run; hence reduce competitive advantage as well. PM team needs to play an active role to ensure that all related actions are efficiently and effectively conducted.

In general, an effective and proactive team can make a very significant contribution to the organization’s performance. The insignificant relationships between PM team and manufacturing performance however might be demonstrated by ineffective and reactive PM team usage. Another possible reason for the insignificant relationship between PM team and manufacturing performance might be to do with the team make up in term of age, tenure [80-83]. An interesting finding from Kang et al. (2006) concluded the importance of team [80]:

‘….cognitive (knowledge, attitude, belief, skill and capability) similarities were important for team performance and commitment, whereas demographic (age, tenure and gender) similarities were not’ (p. 1699).

Therefore, PM team leader must ensure PM team members have common cognitive (knowledge, attitude, belief, skill and capability) similarities in order to achieve PM goals, which are zero breakdowns and zero defects (Nakajima, 1988)[21]. Besides, Nakajima (1988) argues that [21]:

‘When breakdowns and defects are eliminated, equipment rates improve, costs are reduced, inventory can be minimised, and as a consequence, labour productivity increases’ (p.2).

Undoubtedly, the leadership of the team is important. A strong team leadership works on the principles that all team members work closely together towards the same vision to achieve measurable goals [84]. More importantly, ref. [84] offers seven principles that enable companies and managers to effectively handle people as a resource and allow them to turn teams into high performance teams [84]. The seven principles are: no compromise in choice of personnel, employees are responsible for their actions, productive competition within the team, problem solving, leader role as an example, trust to natural team-building, and fostering internal communication. The positive and significant relationship between PM strategy and innovation was anticipated. PM strategy, which includes activities such as continuous improvement efforts, overall equipment effectiveness, and environment and safety related issues, allows more opportunities for volume and human resource flexibility therefore offer more opportunities for innovation. PM is a comprehensive maintenance system that requires commitment from all levels of employees [21]. Therefore, in order to facilitate smooth daily operations PM strategy accommodates a platform for continuous improvement activities to increase operator skills and knowledge to response fast to any changes in the manufacturing environment. If operators are skillful and knowledgeable, many tasks can be executed without incurring big changes in performance [84].

The final dimension of planned maintenance is related to two performances indicator namely financial and organizational capabilities. Moreover, effective planned maintenance can also contribute to productivity improvements by the restoration of deteriorating equipment to maintain basic equipment condition, decrease minor stoppages and reduce set-up time [21],[85]. Planned maintenance is a formal programme that not only makes sure proper time-based maintenance and condition-based maintenance work properly but also that all employees will be well informed about quality and progress [21].

Moreover, through planned maintenance all related scheduled maintenance works are designed accordingly in order to avoid breakdowns of equipment. Hence the status of current production data i.e. reject rates, productivity levels, production losses, accidents, and so forth are made available to all employees for reference and displayed on the information board strategically located on the production floor. The on-going awareness and education programmes about on-time delivery of products to customers must be planned and executed effectively.

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