

Uplifting the Function of Maintenance Management towards Sustainable Performance of Laboratory and Workshop in TVET Institutions

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Abstract

Strengthening of technical and vocational education and training (TVET) is one of the Malaysian government's efforts in producing a skilled and semi-skilled workforce towards meeting the requirement from domestic industry. Under TVET education, the graduates will undergo a various of skills and technical training in either laboratories or workshops (L&W). Of significance, the equipment in L&W plays a vital role in the realization of the roles of TVET. It demand effective management tool and necessity to be in 100 percent availability. However, the literature portrays that there are some risen issues related to maintenance management of L&W, particularly related to resources such as inappropriate budget allocated for maintenance activity, unskilled staff, poor monitoring technique and utilization of conventional maintenance management technique. Hence, this study is aimed at exploring the uncovered issue related to maintenance management of L&W at the selected TVET institutions. Qualitative research methodology will be adopted in the study. Data will be collected at three TVET institutions from different region of peninsular Malaysia. The main concern of this study is three fold, first is to identify the critical success factors (CSFs) in managing the equipment of L&W in the TVET institution. The second part of this study will examine how the MM of L&W can be optimized and embraced the digital age. The study will taking into account the complex interplay between equipment or system in the L&W and the digital systems. In the third and final part of this study, those identified CSFs will be integrated towards a holistic framework to manage the L&W of TVET institution. The framework is beneficial for all stakeholders that directly or indirectly involve in managing, uplifting and sustaining the L&W of TVET institution.

Keywords: Maintenance management; Facilities management; Critical success factors; Sustainable performance; Laboratory and workshop facilities.



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1. Introduction

Malaysia's economy is now in rapid transition from commodities-dominated to industry-based country by 2020. Consequently, the Malaysian government has introduced the Economic Transformation Programme (ETP) framework in 2010, aimed at driving the country toward an advanced nation by 2020 (Prabhakar and Raj, 2014). The main Initiatives under the ETP are projected towards attracting a huge foreign investment, which will create a million of jobs, many of which are high-income jobs. The high-income jobs are closely related with skills and competency are highly sought after by various industries. Therefore, the quality and skills of work force is very crucial towards the success of ETP as well as realizing Malaysia's vision 2020 of becoming a developed nation. The growth and long-term sustainability of the country in achieving a high income economy hinges on structural reforms to produce a highly skilled, creative and innovative workforce (Rasul *et al.*, 2015). The government has recognized the Technical and vocational education and training (TVET) education as a one way to achieve the objective in producing the quality manpower. Due to that, in the recent Malaysian budget 2018, the federal government has spent large sums in supporting the development of TVET (Budget, 2017). TVET is an education, training or learning activity which provides knowledge, skills and attitudes relevant for employment or self-employment. The main thrust of TVET is about acquisition of knowledge and to develop practical and applied skills for the learners (Kayan *et al.*, 2015); (Unevoc, 2018). The acquisition of those relevant skills can only be acquired in a well-established and functional workshop with the right tools, equipment, machines and facilities. This ensures effective implementation of TVET program (Audu *et al.*, 2013); (Ogbuanya and Okoli, 2015). In the Western, TVET is viewed as a tool for productivity enhancement for the nation (Ahmad *et al.*, 2015); (Barkhaya, 2013). The demand for graduates from TVET instruction is increasing yearly, according to the statistics from Malaysia Education Blueprint 2015-2025, there will be an increase in demand for an additional workers by 2020 in the 12 National Key Economic Areas (NKEA). NKEA will require a workforce of up to 3.3 million by 2020 of which 1.3 million are to be graduates from TVET (Malaysia Education Blueprint 2015-2025 MOHE, 2017). Of significance, the laboratory and workshop (L&W) plays an important role in realizing the success of TVET program. This is sequel to the fact that the curriculum in TVET program involves intensive hands on and practical skill including manipulative skill concerned with direct experimentation or production with psychomotor skill (Kayan *et al.*, 2015); (Ogbuanya and Okoli, 2015); (Rahim, 2011). Though verbal skills are emphasized but not to the detriment of manual operation.

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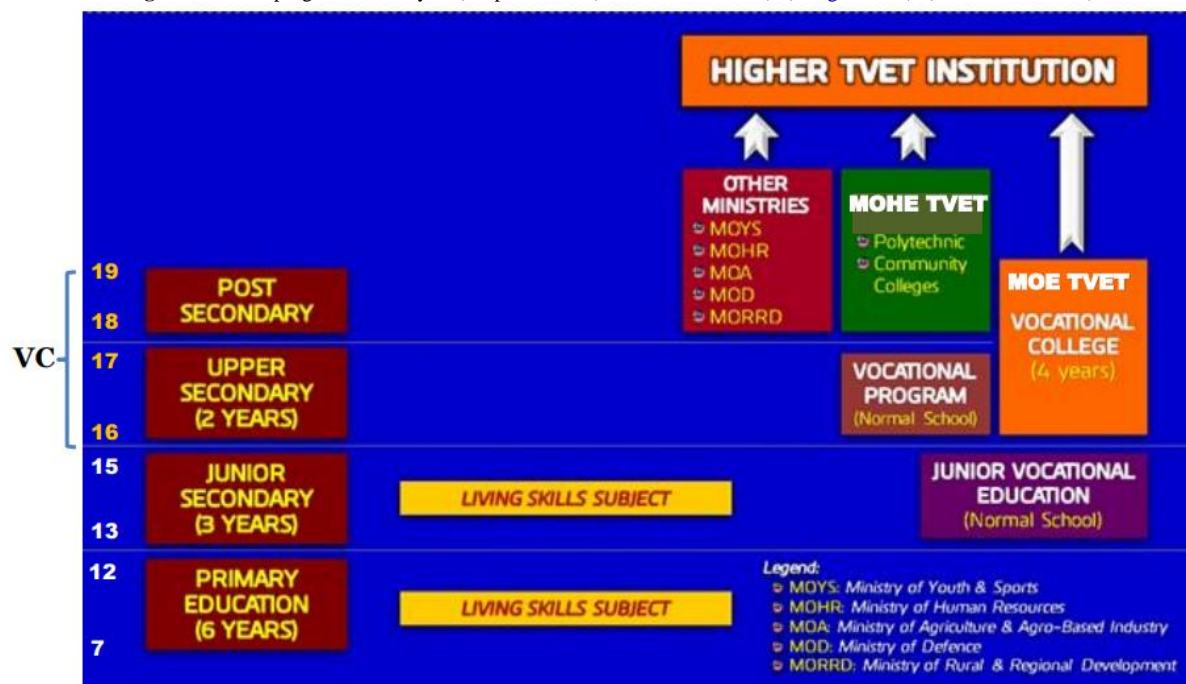
Equipment is needed for efficient achievement of those technical skills. Thus, well maintained L&W equipment and facilities is important factors to be considered while making provision for TVET implementation. It should be well maintained and necessity to be in 100 percent availability (Mohamad *et al.*, 2017); (Mohammed *et al.*, 2012); (Njenga and Kidombo, 2017); (Noor and Idris, 2011). However, the literature posited that there are some risen issues related to maintenance management of L&W, particularly related to resources such as inappropriate budget allocated for maintenance activity, unskilled staff, poor monitoring technique and utilization of conventional maintenance management technique (Ismail Z. and Kasim, 2013); (Mohamad *et al.*, 2017); (Mohammed *et al.*, 2012). Hence, this study is aimed at exploring the uncovered issue related to maintenance management of L& W within the selected TVET institutions in Malaysia. The paper starts with a literature review, focusing on TVET property management experiences in other countries as well as from other research. This is followed by a section detailing the methodology selected for the study. A discussion of the findings is then presented before finally, the paper provides conclusions derived from the research.

2. Literature

2.1. The Importance of TVET Institution

TVET stands for Technical and Vocational Education and Training. TVET is understood as comprising education, training and skills development relating to a wide range of occupational fields, production, services and livelihoods. TVET is concerned with the acquisition of knowledge and skills for the world of work (Hanafi, 2015); (Ismail M. Y. *et al.*, 2009); (Kamarulzaman, 2014); (Laugho and Lillis, 1988); and (Unevoc, 2018). TVET is an important element determining the future direction and pattern of a country. TVET is a vital instrument that can help to improve the quality of the workforce by nurturing the knowledge and skill to ‘world of work’ (Syah, 2015); (Unevoc, 2018). TVET program has a pertinent contribution to the enhancement of country’s competitiveness in today’s globalized world. An orientation towards the ‘world of work’ by emphasising of its curriculum on intensive psychomotor skill is one of the most important features of TVET. The manipulative skill concerned with direct experimentation or production with psychomotor skill ensures the acquisition of employable skills (Amanchukwu and Ololube, 2015); (Barkhaya, 2013); (Hanafi, 2015); (Malaysia Education Blueprint 2015-2025 MOHE, 2017). The Malaysian government has recognized the TVET education as a one of the key component to achieve the country’s goal as a high-income nation by the year 2020. The government continuously formulates, promotes and coordinates TVET strategies and programs to ensure a constant, adequate and timely supply of multi-skilled workers that will able to meet the country’s development (Pasir Mas, 2007); (Pemandu, 2015). In Malaysian 2018 Budget, the Prime Minister has announced an allocation of RM4.9 billion aimed at empowering and to uplift the TVET institutions in the country. Such a huge allocation shows the government’s seriousness and commitment in realising the importance of TVET transformation as the game changer in increasing competitiveness as well as improving the calibre of the workforce and the nation's economic development (Shaharuddin *et al.*, 2016); (STAR, 2017). As an effort for further intensification of skills training of more than 1,000 TVET institutions in Malaysia, beginning 2018, the government also has merged the governance of all TVET institutions into one entity, called as TVET Malaysia. Previously those TVET institution were under governance of seven different ministries as shown in Figure x. Those ministries include: Education Ministry (MOE); Human Resources Ministry (MOHR); Higher Education Ministry (MOHE); Works, Youth and Sports Ministry (MOYS); Rural and Regional Development (MORRD); Agriculture and Agro-based Industry Ministry (MOA); and Defence Ministry (MOD).

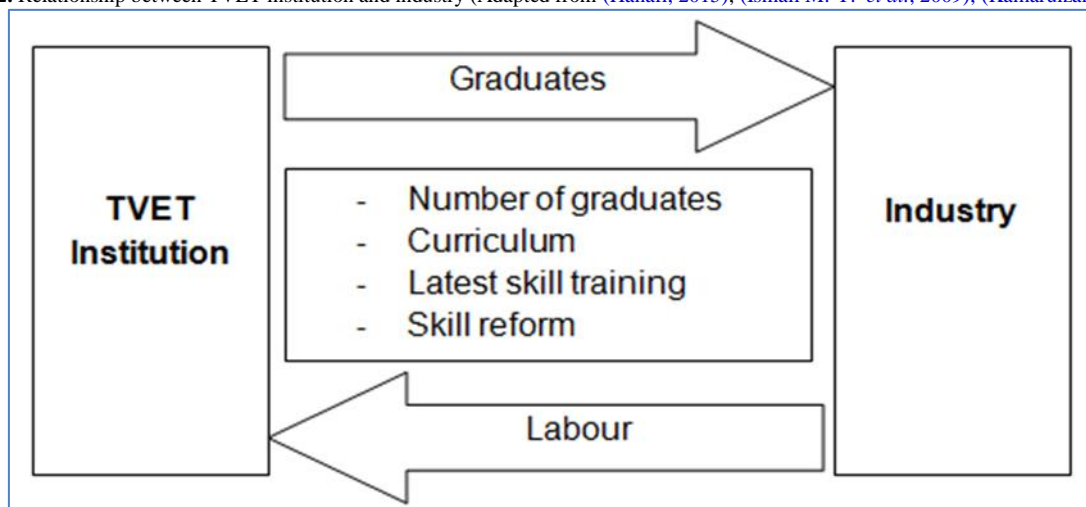
Figure-1. TVET program in Malaysia (adopted from: (Ahmad *et al.*, 2015); (Budget, 2018); (Rasul *et al.*, 2015)



2.2. Component in TVET

TVET programmes in Malaysia are offered at certificate, diploma, and degree levels. The relationship between institutional and industrial systems is a key aspect in technical or vocational education. TVET institutions are responsible for shaping their output with their own mould based the need and demand of the industry (Hanafi, 2015);(Kamarulzaman, 2014); (STAR, 2017). Figure 1 shows the relationship between the institutional system and the industry to produce graduates and workers who have the knowledge and skills suffice in what the industry needs today.

Figure-2. Relationship between TVET institution and industry (Adapted from (Hanafi, 2015); (Ismail M. Y. *et al.*, 2009); (Kamarulzaman, 2014)



The TVET curriculum orientated towards the ‘world of work’ which emphasizes on nurturing and enhancing the knowledge and practical skills follow the needs of employers and industries (Ahmad *et al.*, 2015);(Audu *et al.*, 2013); (Hanafi, 2015). The ability of students to master the practical skills is an advantage to them to gain job opportunities in the industrial sector.

2.3. The Important of Laboratory and Workshop in TVET

The teaching and learning processes in TVET are oriented towards intensive hands on and practical skill in concerned with direct experimentation with specific machine or equipment (Amanchukwu and Olorube, 2015); (Bello and Shu’aibu, 2013); (Buys and Nkado, 2015). Hence, the laboratory and workshop (L&W) plays an important role in realizing the success of TVET program. Equipment is needed for efficient achievement of those technical skills. Thus, well maintained L&W equipment and facilities is important factors to be considered while making provision for TVET implementation. It should be well maintained and necessity to be in 100 percent availability (Alan and David, 1993); (Asiabaka, 2008); (Fredriksson and Larsson, 2012). The physical resources of L&W are valuable assets for TVET institution. This is due a high cost incurred in preparation and acquisition of those specific equipment, machine and facility in the L&W. It is estimated the costs of those resources to reach 20% -30% of the institution’s annual budget. Then the importance of these costs in building, acquiring, maintaining and using of L&W in TVET institution should not be taken lightly(Ahmad *et al.*, 2015); (Ismail, 2015); (Lateef *et al.*, 2009).

4. Maintenance Management of Laboratory and Workshop

There is consensus among many authors that successful of TVET program are influenced by equipment reliability and maintainability. Ineffective maintenance management (MM) on the equipment and facilities of L&W will have adverse impact to all stakeholders within the TVET institution. A huge amount on maintenance of inefficient L&W equipment and facilities would increase the overall institution’s operational costs (Kamarulzaman, 2014). The malfunction and breakdown of equipment in L&W definitely would obstruct the institution from fulfilling the needs of the curriculum thus affect the whole processes of transferring skills to learners. Through a systematic MM such adverse impacts could be eliminated. Therefore, it is very important to ensure that the equipment and facilities of the L&W are well maintained (Lateef *et al.*, 2009); (Olin, 2012); (Othman, 2008).

4.1. Problem and Issue in MM of Laboratory and Workshop

Even though MM program initiative is generally accepted as part of important constituent in TVET institution, however literature highlighted that there are some risen issues related to MM of L&W in the TVET institution. The researcher has categorized those problems into two main categories, i.e institutional and operational issues, as tabulated in Table 1.

Table-1. Issues in Maintenance Management for Laboratories and Workshop

Classification	Issues Highlighted	Authors
Institutional Issues	Ineffective leadership of those authorized to administrate the institution. Absence of MM policies, goals and master plan. Inadequate financial support.	
Operational Issues	Involvement of stakeholders: relevant ministry, head of institution, custodial and user of the L&W. Irregular monitoring. Incompetent staff. Poor attitude of staff. No further after-sales service by supplier. Inadequacy, unavailability and non-functional state of the facilities.	1, 4, 5, 6, 8, 15, 17, 18, 19, 23, 26-29, 31, 36, 37, 44, 47,

Bello and Shu'aibu (2013) carried out a review on the status of MM program implementation in Nigeria institution. Their study discovered that institution under investigation have failed to gain benefits from MM implementation program. They highlighted that the inadequacy, unavailability and non-functional state of the facilities was the reason of failure in MM implementation program. The study by Noor and Idris (2011) highlighted that the failure of L&W equipment to function properly may jeopardize the teaching and learning process. Worst case, it affected the safety of users. On the other hand, Uko (Esther, 2015) highlighted that the unknowledgeable and ignorant management as the main reasons why institution failed to implement MM program. Another recent research by Amanchukwu and Ololube (2015) stressed on the need of thorough understanding of CSFs in MM implementation. They have classified the causes of MM program failure into three major categories namely ineffective leadership of those authorized to administrate the institution, absence of systematic monitoring and lack of maintenance culture. Asiabaka (2008) and Lateef *et al.* (2009) highlighted the issues of lacking of evaluating the performance of maintenance work on L&W. They stressed that currently the maintenance service are done without systematic and proactive approach. Lateef *et al.* (2009) and Mohamad *et al.* (2017) pointed out that the lack of technical expertise to deal with the up-to-date equipment and facilities in the L&W is one of the important issues that need to be addressed. Amanchukwu and Ololube (2015) urged the management to aware about CSFs constructs in MM implementation and take extra precaution while implementing MM program, only then the institution could enjoy benefits in term of business competitiveness particularly on increased productivity and improved product quality (Prabhakar and Raj, 2014). Despite the important highlight to overcome failures and obstacles in MM implementation program from recent literature, as to date there is no comprehensive research to deal with the CSFs constructs in MM implementation program at TVET institution in Malaysia. In order to expand and promote MM implementation program in TVET institution in Malaysia, there must be a strategic implementation plan. As such, further review and analysis of current MM implementation strategy requires further investigation, in order to get a better picture of its status.

5. Critical Success Factors to Improve MM for Laboratory and Workshop

Many researchers would argue that there is no single concrete solution to solve the issues related to MM of L&W for TVET institution. But many successful institutions have a common and specific characteristic that have contributed to the success of their institution. Those common and specific characteristics are termed as Critical Success Factors (CSFs). It is a set of key ideas used to assist institutions to accomplish their strategic goals (Slack, 2015); (Zulkarnain *et al.*, 2011). Many studies investigate the CSFs constructs in various field in which the issues discussed are varied and diverse. In the case of L&W, the management of TVET institution needs to really consider the CSFs constructs in order to success. This would serve as a benchmarking activity towards successful MM of L&W.

5.1. Top Management Support

The role of management of TVET institution to support the TPM implementation is vital and has been addressed by many previous researches. Total commitment from management is a key factor towards the success of MM program on the L&W equipment. Major resources required supporting MM program, particularly human, materials and financial resources are under the decisive role of management, and thus management commitment is a prerequisite. The importance of MM of the L&W equipment as an important constituent of institution management needs to be really understood by the management. The management should have an imperative role in determining MM policies, objective, strategies, allocation of resources and align with overall goals of TVET institution. MM demands a holistic participation from all level of operational staff in the TVET institution; therefore the management has a crucial role in obtaining full participation from staff. The importance of management participation, not to just support and commitment, but also to be fully involved in determining strategy, hands on implementation process, coaching and evaluating MM program in a structured activity that can improve the management of institution assets. The involvement of middle management to support the MM program by coordinating and guiding their down line is essential. The middle managers are those in charge of first-line supervision and their roles in this sense are about

either to make or break the success in MM program. The principle of MM program is on taking care equipment based on teamwork consist of users, maintenance staff and managerial level. The management support and interest in MM program would generate motivation among staff to render full support and participation. Uncommitted management would create a substantial obstacles and difficulty in MM program. Therefore, the issue related to management commitment and leadership is relevant for an in-depth study to determine the level of top management understanding on MM philosophy and the level of support given as well as leadership level.

5.2. Staff Involvement

Although management commitment and leadership is crucial to the success of MM program, however it is not a decisive factor. The readiness of staff to support and participate in MM program is another essential factor to be considered. Human factors are the basis for the development of MM program. No matter how well the institution is equipped with advanced equipment and facilities, it is staff neither manager nor systems who affect the institution's performance. MM program initiative demands a radical change in the mind-set of staff towards improving the work culture in the institution. The evolution of shifting the mind-set of staff is a tough task for the top management and it requires patience and time, investment of dollars and allocation of resources. The institution needs to have a strong organization structure to ensure the smooth running of MM program. This research focuses on the organizational change during the MM program, particularly related to the issue of managing initiatives towards obtaining full staff participation.

5.3. Development of Staff Competency

Training and educational issues is another CSFs constructs to be focused in MM program (Njenga and Kidombo, 2017). Sufficient and effective training programs would develop staff competency, skills and knowledge to detect abnormalities in the equipment condition at earliest stage. It is crucial to nourish the technical knowledge to the staff in order to maximise the effectiveness of MM program. The importance of technical knowledge is part of the philosophy of MM, as MM itself is a technical process to achieve world class maintenance. The development of staff participation is the most fundamental structure that often has lack of emphasises. They emphasized training and education to ensure the staff makes a shift in their thinking to voluntarily take care of their equipment. A sincere sense of ownership and active participation from staff towards their equipment will benefit the institution. The end results of MM program would be translated into tangible benefits such as reduction in equipment breakdown, lower cycle time, reduce in set up time and improve the service to the users / learners. Through an effective training and education program, the scepticism about maintenance role as non-productive and non-profitable activity to the Institution operation can also be corrected. The importance of evaluation on any training and education program to ensure that staff' commitment, knowledge and skills are at excellent level. Asiabaka (2008) on the another hand, discussed issues related to training and education in organization such as poor understanding on the necessity of training by the management, insufficient resources to carry out an effective training program, poor planning for employee substitution whenever they are absence from the workplace for training and insufficient funds allocated for training. Amanchukwu and Ololube (2015) emphasized that in view of the huge cost of procurement of new material, maintenance culture should be upheld in schools or be made a priority. When school plant is taken care of, they last long thereby saving costs for the government.

5.4. Strategic Planning and Implementation Approach

Mohamed (Mohammed *et al.*, 2012) highlighted that in order to ensure the success of MM program of L&W equipment and facilities, the approach should be realistic with appropriate strategic planning. Strategic planning is defined as recognizable set of activities. These include: establishing and clarifying the institution's vision, mission and driving forces; assessment of the institution's internal strengths, weaknesses, external opportunities and threats (SWOT); developing necessary action plan; allocating appropriate resources; fostering communication and teamwork among management and staff; measuring results and monitoring progress. A systematic MM program is not an overnight effort, the feasible maturity state for MM program highlighted from literature, is from three to five years (Omar *et al.*, 2017); (Slack, 2015). Therefore an appropriate strategic planning with a clear identification of institution goals and how it's going to attain those goals is a must. Slack (2015) noted on the importance of strategic planning, they advised to start MM program with a small-scale pilot projects in order to cope with the uncertainty during initial stage. The pilot project is also useful to improvise strategies for full-scale implementation. Benchmarking with established MM standard is part of essential elements during planning stage. Benchmarking visit and learning from other institution which succeeded in MM of their L&W equipment and facilities would shorten the learning curve and implementation process. Benchmarking activities will benefit institution in drafting an explicit and achievable implementation plan. Generally for countries outside Japan, the TPM implementation method is tailored to a specific requirement particularly subjected to a specific culture, technology capability, environment and political system. In principal, there is no perfect method for MM program and there has been a divergence of approaches adopted throughout the countries and industries. However, it is necessary to find a realistic method for a smooth application, with a good impact, that permits a trouble-free reformation (Sezdi, 2016); (Tabikh and Khattab, 2011). A holistic MM approach by emphasizing maintenance trilogy: maintenance planning, maintenance control and maintenance improvement requires involvement of the institution stakeholders and those constituents within the supply chain of the institution (Sallehuddin, 2013).

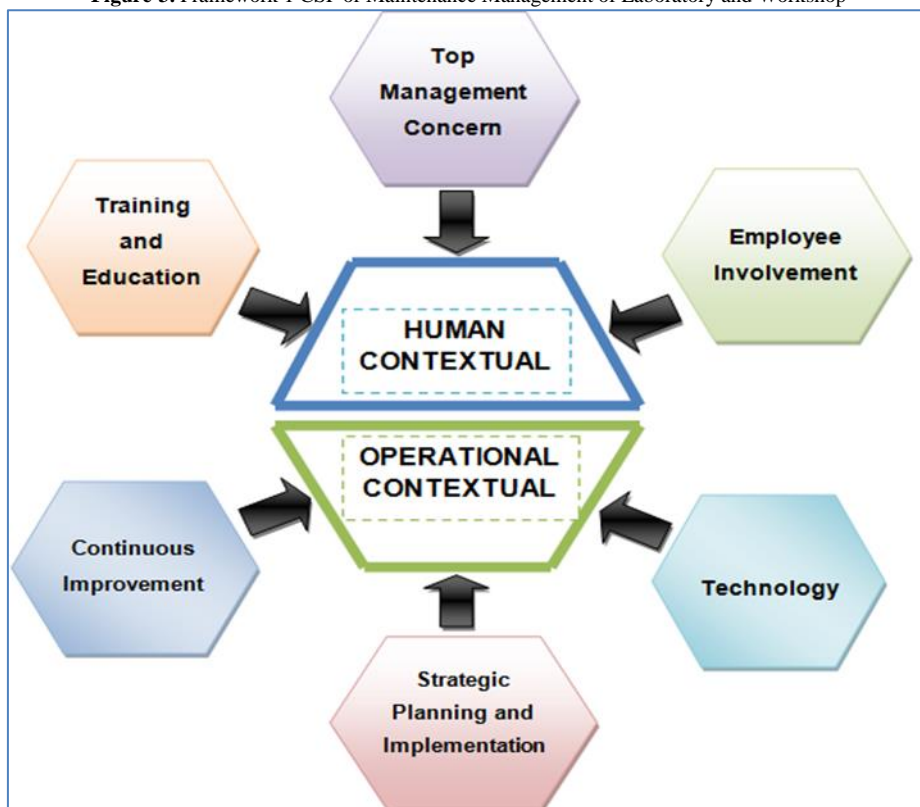
5.5. Performance Measurement and Continuous Improvement

Measurement of performance and evaluation on progress of MM program would enable management to review the achievement and further improve any hiccups in implementation program. MM program can only succeed in an institution that is committed to allocate time to monitor the progress of MM program. For instance, proper assessment the training given to staff is vital in order to ensure that staff commitment, knowledge and skills are at excellent level. It is important to know whether staff really understands the terminology and philosophy taught therefore what have been preached would come forward in the workplace. The staff should understand what is expected from them. Appropriate monitoring and evaluation on the implementation status would ensure the implementation program follows the correct pathway. If the results is not favourable or have not met the expectation, an immediate analysis on the root causes need to be carried out. Consequently changes or improvisations to the related activities must be promptly made so that the inappropriate practice or direction is not continued.

6. Development of the Research Framework

This study aimed at further exploring the uncovered issue related to MM of laboratory and workshop in TVET institution. Towards achieving the final objective of this study, it is essential for researcher to assess on the actual MM practice in the L&W, particularly to validate which CSFs constructs are well addressed and which constructs are yet to be addressed (Kedar and Borikar, 2016; Omar *et al.*, 2017). In view to that purpose, the research framework is developed as preliminary research tool. Based on the findings and literature review, a conceptual framework was then developed. The end route of this framework focuses to compare the actual emphasize of CSFs constructs against the positive extent of MM practiced in the L&W. Throughout the extensive review of the present literature, six CSFs constructs were identified as having the most significant impact in MM of L&W were illustrated in Figure 3, These six CSFs is aligned with the issue of MM of L&W as discussed earlier.

Figure-3. Framework 1 CSF of Maintenance Management of Laboratory and Workshop



The MM issues categorized under the human contextual are the issues related to top management concern, employee involvement and development of staff competency via training and education. Vice versa, the issue related to strategic planning and implementation, continuous improvement and technology awareness are categorized under operational contextual. The MM – L&W Framework 1 outlines six CSFs to support achieving the objective of MM for L&W: top management concern, staff involvement, training and education, strategic planning and implementation, continuous improvement and technology. It was further classified as two groups of CSF. The first group of CSFs refers to the human contextual where top management concern, employee involvement and training and education are the elements in order to achieve a good and successful MM for laboratory and workshop. Top management concern and staff involvement are very important elements to make sure, maintenance management keep on going in right way and get full attention from everyone in organization. Training and education is a function to increase the employees and managers' knowledge and skills. Training should be followed with a program based on goal setting and performance feedback. Ongoing, the team, especially the personnel, should be trained to increase their knowledge and skill. With this, it will guarantee the maintenance to be run successfully in the future. Whereas

the second group of CSFs refer to the operational contextual where there are strategic planning and implementation, continuous improvement and technology as the elements of the successful MM for L&W. Strategic planning and implementation is the way that will make sure whether the goal and objectives in MM for L&W in TVET institutions are achieved. To ensure the maintenance jobs are done successfully, it is necessary to implement with direct and control it in a systematic manner. On the other hand, continuous improvement in maintenance management for L&W also need to give concern on it to make sure the better care of the facilities in L&W for better teaching and learning session. Technology refers to the application of latest and advancement tools and technique in managing the MM for laboratory and workshop.

7. Conclusion

From previous research, it stated that to enhance the effectiveness in maintenance management process, the facilities and infrastructures need to be refurbished. For better maintenance on facilities and infrastructure, the conventional method has to be improved while to provide a good environment. In the conventional method, the main problems faced by maintenance management are the technical and managerial defects. From the aspect of a technical defect, the problem is the lack of technical expertise to operate and monitor the facilities and infrastructure with new technology. Thus, it will drives to the best practice in managing L&W for the better indication in providing the good facilities in future and guarantee that a long-term wait for benefits is worth it. This literature review presents the overview of the CSFs for the effective MM approach in L&W. Facilities management is an integral part of the overall management of the TVET institution. The proposed framework would provide comprehensive guidelines and understanding on how MM should be conceived, managed and integrated with other key management activities within the context of TVET institution in Malaysia. It would also provide a clear and holistic understanding of the best practice approach to the MM for TVET institution. However, there are some drawbacks to this proposed framework. The proposed framework is based on literature only and there is a need to carry out thorough an empirical research to validate those CSFs highlighted (Unevoc, 2018); (Zulkarnain *et al.*, 2011). Any issues identified will be further addressed in the main research which is ongoing.

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