The Proliferation of Knowledge-Based Workforce in Knowledge-Based Economy: Evidence From Malaysian High-Tech Industries

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Abstract— This study implements a survey using a random sample of organizations that represent the industrial and government sectors in Malaysia. The results of the study showed that more than half of the sample have employees with IT and technology skills. Larger companies will require more non-ICT workers in the future than small companies. In terms of productivity, service-based companies have better productivity performance than production-based companies. This advantage can be seen as a challenge for the industrial sector in adopting advanced technology and ICT in the present knowledge economy.

Keyword— Knowledge Workers, Knowledge Economy, SMIs,

I. INTRODUCTION

Malaysia is fast moving toward obtaining a knowledge economy (k-economy), which is underpinned by innovation and enterprise. This progress is further expedited by industries known to encourage innovation, promote competitiveness, and create employment and wealth in the society [1]. Industries can play an important role in leveraging the national economy by having a workforce that is highly skilled, trainable in new technology, and knowledgeable. These industries have the capability to be more innovative, can provide greater flexibility to the economy, and encourage the creation of new jobs. A healthy competition can subsequently exist in both domestic and international markets. With the present globalization, industries are now commonly expanding to international settings with the help of IT, specifically the Internet that allows e-commerce and increases competitiveness [2]. A knowledge-based economy requires a workforce that is highly skillful, learned, and innovative. Industries under this economy possess a positive motivation and attitude, are innovative, and have entrepreneurial skills that allow them to take advantage of many opportunities that are widely available as a result of globalization and the proliferation of advanced technology.

To achieve a knowledge-based economy, greater emphasis should be given in enhancing the workforce by equipping them with academic credentials, technical requirements, and the right skill set that can increase their work efficiency as well as boost their positive attitude and creativity. Knowledge workers (k-workers) are vital for the transformation of a nation to a knowledge-based economy.

Reports on the current scenario of human resource development in Malaysian SMIs had not been encouraging. SMIs in Malaysia are still operating in a traditional manner and are mostly family-based [3]. SMIs continue to use traditional and obsolete technology to produce cheap and low-quality products with limited market penetration. Among the problems faced by SMIs include the lack of able personnel to negotiate funding, skilled workers and learned manpower [4],[5] and expertise in using and managing technology [6], as well as the low level of IT skills and knowledge [7], poor user attitude toward technology, and low skill/knowledge level in using equipment for maintenance work [8]. Other problems include the lack of resources or facilities in carrying out effective training programs and the difficulty in hiring employees to be trained as substitutes [9].

Previous studies had shown a close relationship between individuals and the organizations they belong into. This finding is linked to the characteristics of human resources that contribute to organizational development, including organizational and managerial capabilities, speed and flexibility, organizational learning, and integrated multiple competencies [10], as well as flexibility and adaptability ([11],[12]). Individual capability has increased by identifying the appropriate skills, knowledge, behaviors, and capabilities required to meet current and future needs for personnel selection; the ability to focus individual and group development plans is also required to eliminate the gap between competencies requested by a project, job role, and enterprise strategy ([13],[14]).
Sophistication, organizational characteristics, and organizational performance have some effect on the adoption or non-adoption of management competency in organizations [15]. The following are also required: skill supply with skill demand [16], skills and knowledge management [17], organizational rules for implementing change [18], individual workability ([19];[20]), performance measurement [21], and high achievement [22]. In the present k-economy, human resource development is focused on the capability of individuals and the organization they support to adapt to the latest information and communication technology (ICT). This ability to adapt ensures the capability of the organization to compete globally according to current demands. This paper attempts to make an assessment of human resource development based on the application of ICT and other related technology in Malaysia.

In developed countries, an increasing number of industries are adopting IT in their effort to obtain a competitive advantage and maintain their position in the market. A study in the UK found that even small industrial firms with less than 100 employees adopt IT by using at least one PC to support their business [23]. The study found that firms adopt IT to improve operational procedures, produce information at a low cost, make new management tools for decision making available, facilitate billing and invoicing, facilitate business growth, facilitate inventory control, and to be innovative. The benefits derived from IT include better record keeping, timeliness, accuracy, expanded information, improved customer service, increased productivity, and enhanced management control and decision making. These benefits have encouraged an increasing number of firms in the industrial sector to adopt IT. However, studies had also shown that the industrial sector, which constitute more than 90% of small- and medium-sized industries [24], generally has end-users with low levels of computer literacy and who receive only elementary formal education. In addition, these industries also lacked qualified IT personnel, specific policy and planning on IT adoption, formal IS methodology, and end-user participation, as well as minimal technology diffusion throughout the firm [25]. This paper also assesses the IT adoption level of Malaysian industries as well as the public sector in terms of end users, IT personnel, education and training, and the types of technology and IT products used as a form of comparison.

II. METHODOLOGY

The study is a field study that implements a cross-sectional survey involving a sample of firms representing production and manufacturing firms listed in the Federation of Malaysian Manufacturers [26] and government and government-linked companies. Proportionate random sampling was used to consider different sample frame sizes according to the industries[27]. A total of 1,000 firms were selected. Questionnaires were distributed to the selected firms, and 120 questionnaires were received. Among the firms chosen to accomplish the questionnaires, 46 firms were categorized as small-sized (with less than 50 employees), 29 firms were medium-sized (between 50 to 199 employees), and 45 were large-sized (with 200 and more employees). Questionnaires with self-addressed stamped envelopes were sent to the selected firms in the FMM list, along with a cover letter describing the aims of the study and instructions in accomplishing the questionnaire. A supporting letter from the Ministry of Science Technology and Innovation was also attached to exhibit the authenticity of the study and to encourage better response. Twelve percent of the questionnaires were returned, which was considered small but represents the typical response rate reported by other studies on SMI s, that is, from 10% to 20% ([28];[29];[30]). Data entry was carried out using a statistical package within which a database of returns was created. Data analysis was subsequently conducted using descriptive statistics on the demography, manpower requirements, technology and IT adoption, and training of the firms.

III. ANALYSIS OF FINDINGS

Table 1 shows the distribution of respondents according to the states in Malaysia. All states were included except Sabah, while Sarawak and Negeri Sembilan states only had one respondent each. The highest percentage of respondents in the sample came from Penang and Selangor, each with 19.2% of the total sample size of 120, and followed by Kedah (15%) and Perak (13.3%). Smaller samples came from Johore (7.5%), the Federal Territory of Kuala Lumpur (5.8%), Melaka (5%), Kelantan (4.2%), Trengganu (4.2%), and Pahang and Perlis (2.5% each). The distribution of the sample by region shows that majority of the sample respondents came from the central region at 38.33%, and then followed closely by the northern region at 36.67%. The southern region and the east coast are less represented at 13.33% and 10.83%, respectively.
TABLE 1
Distribution of the sample by region

<table>
<thead>
<tr>
<th>Region</th>
<th>States</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Region</td>
<td>Perlis</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kedah</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Penang</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>44</strong></td>
<td><strong>36.67</strong></td>
</tr>
<tr>
<td>Central Region</td>
<td>Perak</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selangor</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kuala Lumpur</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>46</strong></td>
<td><strong>38.33</strong></td>
</tr>
<tr>
<td>Southern Region</td>
<td>Negeri Sembilan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Melacca</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Johore</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>16</strong></td>
<td><strong>13.33</strong></td>
</tr>
<tr>
<td>East Coastal Region</td>
<td>Pahang</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trengganu</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kelantan</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>13</strong></td>
<td><strong>10.83</strong></td>
</tr>
<tr>
<td>East Malaysia</td>
<td>Sabah</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sarawak</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>1</strong></td>
<td><strong>0.83</strong></td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL:</strong></td>
<td><strong>120</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

The distribution of the sample suggests that ICT and high technology industries are concentrated in the central and northern regions of Malaysia. This observation is supported by the development of industrial and high-technology parks and free trade zones in the Klang Valley areas situated in the central region and of the Bayan Lepas Free Trade Zone, Prai Industrial area, and the Kulim High Technology Park in the northern region. Therefore, the sample is proportionate to the distribution of the industry targeted for this study, and findings from this report well-represent the technology and ICT industry in Malaysia. The survey also examined the number of companies involved in the Multimedia Super Corridor (MSC) initiative introduced by the government of Malaysia. However, only a small percentage (10%) of the sample indicated their MSC status. A closer investigation of these companies shows their location in Cyberjaya, Selangor. Figure 1 shows the percentage distribution of MSC and non-MSC companies in the sample. Notably, 100 from 120 companies responded to this question.

In terms of company ownership, majority of the companies in the sample are Malaysian and locally owned, accounting for 58.3%. Foreign-owned companies accounted for 22.5% of the sample, while the remaining 19.2% was from the government sector. Comparison of the human resource development for both technology and ICT usage among the three major sectors, which will be presented later in this report, is interesting. Figure 2 shows the ownership distribution of companies in the sample.

The size of the companies in terms of the number of employees was examined to complete the presentation of the general background of the companies in this study. Table 2 shows the distribution of the companies in the sample by category, that is, small-, medium-, and large-sized companies. The table shows that small-sized companies in the survey with employee size of less than 50 accounted for 38.3% of the sample. Medium-sized companies with 50 to 199 employees comprised 24.2% of the sample. Large-sized companies with 200 and more employees constituted to 37.5% of the sample. Therefore, majority of the respondents come from small- and medium-sized enterprises (SMEs), accounting for 62.5% of the sample.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Employees</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>49 and below</td>
<td>46</td>
<td>38.3</td>
</tr>
<tr>
<td>Medium</td>
<td>50 to 199</td>
<td>29</td>
<td>24.2</td>
</tr>
<tr>
<td>Large</td>
<td>200 and above</td>
<td>45</td>
<td>37.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>120</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

The succeeding section of the survey analyzes the availability of skilled workers for the adoption of technology and/or ICT in the company.
Figure 3: Availability of skilled workers in technology and ICT adoption

Figure 3 shows that more than half of the companies in the sample had skilled workers in both technology and ICT at approximately the same proportion. Though the data may appear encouraging, a significant number (46%) of respondents indicated they did not have a sufficient number of skilled workers in both technology and ICT. Considering that majority of the sample respondents came from industrial areas, this finding is not ideal. A significant number of organizations within the industry still experience difficulty in acquiring positions that require skills and expertise. A closer look at the distribution of skilled workers shows that, for the technology industry, slightly more than 30% of the companies have 10 or fewer skilled workers. In the technology sample, 23% indicated having more than 50 skilled workers, and approximately 45% have 10 to 50 skilled workers. For the ICT category, 25.5% have fewer than 10 skilled IT workers, and the same proportion indicated having more than 50 skilled workers. The remaining half of the sample for the ICT category has 10 to 50 skilled workers. Figure 4 shows the distribution of the technology and ICT samples according to the number of skilled workers available.

Figure 4: Number of skilled workers in technology and ICT industries

The result shows that majority of the companies had 25 or fewer employees in all management level categories, ranging from as low as 64.2% at the operations level to 75.8% at the middle level. The figure presently increases to 92.6% at the top management level.

Figure 5: Distribution of workforce by management category

The increasing trend is seemingly consistent for the next five years, as the figures indicated. However, the demand for management workforce across all three management levels slightly decreased. A slight decrease was observed at the top-level management, suggesting that the respondents do not perceive any increase in workforce demand in the next five years among companies with 25 or fewer employees across all management levels. The larger the company, the trend appears to be the opposite where an increase in management workforce demand is supposedly observed for the next five years across all three management levels. The operations level showed the highest increase, as shown in Figure 5. Larger companies are expected to have more job openings for all management categories, particularly at the operations level of Malaysian technology and ICT industries within the next five years.

Figure 6: Distribution of workforce by technology
The trend of the workforce in the technology industry shows an equally distributed proportion of skilled, semi-skilled, and unskilled workers for companies with 25 or fewer employees across all three categories. Notably, approximately half of the sample had 25 or fewer employees across all three categories. In examining future trends, Figure 6 demonstrates a slight decrease in the demand for technology workforce in the next five years for companies with 25 or fewer employees across skilled, semi-skilled, and unskilled worker categories. However, the biggest decrease was in the semi-skilled worker category at an almost 7% reduction. Unskilled workers had the least decrease in demand at only 2%, as shown in Figure 6.

As mentioned previously and indicated in Figure 6, larger companies tend to have an increased demand for skilled, semi-skilled, and unskilled workers in the next five years. Thus, unlike small companies that tend to have less demand for technology workforce in the future, large companies require a sufficient number of technology-capable employees within the next five years. This finding is particularly true in the semi-skilled category where the demand appears to be the highest.

The current demand for ICT workforce is therefore in the ICT support category, followed by the categories requiring database administrators, systems analysts or application developers, and desktop publishing specialists. The demand for hardware or computer engineering was comparatively lower at 79.1% of the companies with 25 or fewer employee sample. However, in the next five years, the demand for computer engineers was predicted to increase by 2%, as suggested by the trend in Figure 7a. Desktop publishing specialists are also predicted to increase at a rate of 3% in the next five years, as presented in Figure 7b. The demand for computer support specialists, systems analysts, and database administrators are expected to decrease at 3% to 4% in the next five years.

A significant proportion of the sample in this study exhibited a demand for non-ICT officers who use computers in their daily operations. For companies with 25 or fewer employees, 59.7% of them employed non-ICT officers. Thus, almost 60% of the companies employed non-ICT officers who became knowledge workers. The transformation can be considered as a significant development toward becoming a knowledge society. However, in the next five years, the number of non-ICT workers will be reduced by 7% in companies who employ 25 or fewer employees. A closer examination of the data shows an upward trend in the demand for non-ICT workers in the large-sized companies. For example, in companies with more than 100 employees, a 5.1% increase in the number of non-ICT workers is expected in the next 5 years.
Similarly, for the 26 to 50 employee category, a 6.4% increase is predicted. Thus, either large-sized companies will require more non-ICT workers in the future or the demand for k-workers will increase for large-sized companies unlike that for small-sized companies.

Figure 8 shows comparison among companies on the level of ICT adoption in the administration, operation, and software application areas. Except in software applications, the ICT adoption level is higher in administration applications than that in operations applications. In the former, an average of 55.6 applications is semi-automated and only 31 applications are fully automated, while in the latter, an average of 49.4 applications are semi-automated and only 28.2 applications are fully automated. Thus, semi-automated applications dominate both administrative and operative applications. Interestingly, traditional word processing (use of typewriter), manual spreadsheet, project planning, and human resource planning are still manually used. However, on the average, only 8.43 applications are manually accomplished. Software usage in fully automated applications is the highest at an average of 61.9%. The sample respondents also indicated that a number of applications are performed in planning, where software usage is highest at 4.86 applications. The results also showed that more operation applications are planned compared with administration applications.

The results indicated that only a small percentage of the sample (20% for B2C, 21.7% for B2B, and 25.8% for B2G) has not experienced e-business. Therefore, up to 80% of the companies in the sample have participated in e-business. The participation in the B2C category was among the highest, followed closely by the B2B category. The B2G category had the least participation at 74.2% of the sample.

Among the most frequently used e-business was B2C, whereas the least used was B2G. An ample opportunity to expand e-government initiatives remains, particularly at the state, local government, and the district and housing or village levels. Only with the implementation of these initiatives will Malaysia fully realize its potential to achieve a knowledge-based economy through a knowledge-based society.

Figure 8: Comparison of ICT adoption level

Figure 9 shows the usage of e-business applications among the respondents. Three categories of e-business were were identified. Business-to-business (B2B) refers to electronic transactions between companies, business-to-customer (B2C) refers to the availability of electronic facilities provided by a company to its customers, and business-to-government (B2G) refers to the portion of the e-government initiative that provides online access for companies and individuals to government services.

On technology adoption, intermediate technology dominated fully and semi-automated categories, which suggests that solutions for technology adoption are currently most popular in intermediate technology that is more economical than integrated technology but has the power and capability exceeding those of stand-alone technology. Figure 10 shows the trends in technology adoption, from fully manual to fully automated technology. Intermediate technology also dominated the fully manual category. However, for future planning, the trend indicates a shift toward integrated technology. Industries should consider integrated technology as increasingly feasible and economical integrated solutions in their entry to the era of globalization and in becoming more competitive.
As organizations adopt IT, ICT training requirements become increasingly necessary. Respondents were asked on the frequency of their conduct of ICT training for their staff members in the administration and operations areas. The result showed that administrative staff members undergo more frequent ICT trainings than their operations counterparts. This result is relatively surprising given the requirement for operations personnel to be equipped with the necessary ICT skills and knowledge to become effective and efficient end users who are responsible for the day-to-day operations of the business. Figure 11 shows the frequency of ICT training attended by administrative and operations personnel.

Figure 12 shows the frequency of technology training according to the three technology categories, namely, stand-alone, intermediate, and integrated technologies. The graph indicates a trend in technology training that must be addressed, in which a high proportion of the sample in all three technology categories have none or very little training on the technology they adopted. The result showed a decrease in the average technology training in all three categories as the frequency of training increases.

Competent and skillful technology adopters are achieved after sufficient training, and firms must be prepared to allocate an appropriate training budget.

The final part of the questionnaire examined the productivity of the respondent companies based on whether the companies are production-based, service-based, or both. Figure 13 illustrates the result of the productivity trends from low, moderate, to high productivity, as indicated by the respondents. Service-based companies have better productivity performance than production-based companies. The graph indicates that productivity performance for service-based companies increases from double at the low to moderate productivity to almost triple at the high productivity category. This finding suggests that more focus should be given to the service industry to help accelerate the Malaysian economy, particularly in the effort to become a fully developed nation in the near future.

IV. DISCUSSION AND CONCLUSION

The development of human resources contributes to sustainable productivity for continued economic growth. Thus, this study assesses human resource development based on the application of information technology in the industrial sector, specifically in SMEs in Malaysia. The present study suggests that the industrial sector should be aware in adopting ICT and other advanced technology to generate a high value-added economy.
This study has also shown that a large vacuum exists for well-educated skilled manpower in the areas of IT and other high technology for SMEs in the industrial sector. The findings may not be favorable in the era of the k-economy at present, where the demand for progress in high technology development and IT is high as a result of globalization. The findings revealed a low level of IT manpower and low technology adoption among SMEs. The requirements for skilled human resource in ICT and knowledge for other technologies have shown high percentages of fulfillment in terms of manpower requirements. K-workers, such as employees with technology and ICT skills, adopt IT products in carrying out their job functions. The percentage of k-workers with technology skills was found to be higher than those with ICT skills.

The size of the k-workforce at the managerial level was found to fulfill the requirement. However, higher job demands are expected in the future for all three managerial levels. Moreover, high staff turnover is anticipated as other companies expand their operations after the recent economic recovery. The results of this study in terms of technological skill suggest that the current need for all categories of skilled and unskilled workers is almost fulfilled. However, the demand for skilled and unskilled workers may increase in the future. In addition, relevant training programs should be given to specific employees. Firms should also be encouraged to support re-training to address the issue of trainees not being adequately trained. Moreover, firms should consider introducing incentives to encourage employees to increase their ICT literacy. The government may also consider subsidizing tax incentives for training programs to encourage SMEs to invest in ICT and high-technology training. With the current technology and ICT capability, further research and development work should be carried out to determine the best use for technology and ICT in training, either through computer-assisted learning and instruction, e-learning and/or using virtual reality, or other modeling and prototype development.

REFERENCES


