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Embracing Industry 4.0 - Guidelines for Managers

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Abstract—*The Industry 4.0 or Fourth Industrial Revolution (used interchangeably in this context)as it has been more broadly known, can potentially change the way modern organizations design, manufacture, deliver and service their products. However, due to the lack of a universal framework for the application of Industry 4.0, businesses find it challenging to become a part of the revolution. Managers primarily encounter difficulties in planning the implementation without any proper guidelines. Hence, article aims to find answer to the question "What factors managers should consider when they apply fourth industrial revolution?"Towards that end, this research carries out a literature review to obtain primary data from academic articles on the implementation / application of Industry 4.0 / fourth industrial revolution. This study eventually came out with Ten factors that should be considered by managers in the application of Industry 4.0 apart from delineating several limitations as well as issues. Implications wise, this study would facilitate practitioners and managers properly.*

Keywords-- *Fourth Industrial Revolution, modern organizations design, manufacture, deliver and service their products.*

I. INTRODUCTION

Massive improvements in digital transformation have affected the way modern businesses are carried out in terms of the way they do their businesses, how to carry out production and how they govern. The multi-level innovative capabilities of business models are made possible by the radical developments in ICT infrastructure and analytical capacities. The mastery of these aspects by the organizations has enabled to form a distinctive competitive advantage. Industry 4.0 entails a digital factory concept or a fully-automated manufacturing process incorporated into the supply chain thus reducing the need for human involvement to a bare minimum [1]. It is mainly linked to the fourth industrial revolution [2]. Fourth industrial revolution heavily focuses on automation, interconnectivity, machine learning as well as real-time data encompassing Internet of Things and Smart Manufacturing. This demarcation is a synthesis of the delineations made in prior studies, combined with several technical aspects for a strategically-planned implementation. To derive positive outcomes, a purposeful introduction and strategic combinations of Industry 4.0 are needed [3]. The implementation of Industry 4.0 is influenced by the market structure, the organization's location, ICT infrastructure level, culture, human talents capacity, political and economic strength, expected benefits and so on. Kamble et al.[4] emphasized on the effects of perceived value and technological readiness. The concept of Industry 4.0 has been shown to be poorly demarcated in terms of its structure and approach for implementation. As opposed to Enterprise Resource Planning and other automation solutions, the implementation of this is different because apart from automation, the creation of its flexible business structure also requires self-regulation, decentralization of making decision and assimilation of all value chain

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essentials horizontally, vertically and from end-to-end. While other automation solutions resort to partial strategic implementations, Industry 4.0 is more complex as it involves the full digitization of the business environments so as to create strategic competitive advantage. Due to this, managers need practical advices for employing Industry 4.0 in their organizations.

II. RESEARCH METHOD

This study intends to explore the important factors for managers while employing Fourth Industrial Revolution. A review of literature was carried out entailing the review and analysis of articles on the implementation of Industry 4.0published from

Guidelines for Managerial People in 2010 to January 2019. Applying Fourth Industrial Revolution

The ten guidelines for managerial people– grouped into three themes – as taken from past literatures are presented here.

Theme 1: Assessing organizational preparedness for applying fourth industrial revolution

Guideline 01: Managing initial investments: The smart factory implementation in this Revolution is driven by the virtual-physical system. Automation agencies have proposed various architectures for the applying fourth industrial revolution. Researchers have developed a popular architecture that elucidates this. The first stage entails the physical link between a machine plus its peripherals in generating precise and consistent information; second stage entails the conversion of the data derived from the connection stage into information; the third phase entails cyber i.e. the great information hub utilized for predicting, examining and observing the operations of the linked machines in the hub, the fourth stage entails the analytical phase where the data undergoes processing via artificial intelligent networks to determine the finest strategy; and the final stage of configuration entails the feedback component to the physical one. As the model was identified to be incomplete, it was extended into the more comprehensive model 8C which integrates coalition, content and customer [10] on top of the 5C model. The coalition stage entails the production process' integration mechanism for value chain and product chain; the customer stage entails the capturing of customer usage data, specifications and so on throughout the production process; meanwhile, the content stage entails the extraction, storage and inquiry of product traceability. A substantial initial investment is needed for implementing this architecture, as strategically accomplished by the managers. The benefits of this model include lesser quality issues, fewer material wastes, decreased labor and operational costs as well as better capacity and speed, all of which lead to a lower overall cost and larger market share.

Guideline 02: Assessing organizational readiness for fourth industrial revolution: Prior to applying this, managers must initially assess the prevailing readiness of their organizations in implementing Industry 4.0. Numerous assessment tools are available in the marketplace. According to Sony and Naik [5], the broadest themes for assessing this aspect are: What is the level of readiness in terms of business tactic for implementing fourth industrial revolution? b) How far the organization has gone in digitizing? c) How much the supply chain has been digitized? d) What is the smartness of the products and services at present? e) Would the people in the organization embrace fourth industrial revolution? And, finally, Is the top management committed and well-informed about

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Industry 4.0? All aspects in the business are critical to the application of fourth industrial revolution. Hence, the aspect of business strategy readiness in all magnitudes needs to be assessed.

Digitization level entails the proportion of organizational assets that are able toself-communicate self-control and self-supervise in a digital manner using sensors. Industry 4.0 is implemented via parallel, perpendicular and end-to-end integrations. The digitization level determines the integration architecture design for the cyber-physical systems i.e. whether new or retrofitted. A high digitization level suggests high organizational readiness. Organizational readiness is also determined by the digitization level of the supply chain. Fourth industrial revolution requires a comprehensive supply chain digitization and the integration of the organization with the cyber-physical-system [7]. A high supply chain digitization levels suggests high organizational readiness.

Smart products and services are also influential to organizational success. Smart products are made up of modular and compatible work pieces. The status of these products will be communicated throughout the various stages of the products' life span, leading to optimized resources for manufacturing, operating and maintaining the said products [7]. The application of fourth industrial revolution will modify the overall working atmosphere thus requiring greater skills for most of the current jobs [8]. Hence, employees need to be highly adaptable to the top skills required. Businesses must be ready for implementing fourth industrial revolution since it is also highly affected by the top management's support and commitment [9] as well as knowledge about the concept. A high level of organizational readiness in all the aspects above indicates the high probability of a successful implementation of fourth industrial revolution.

Theme 02: Strategies for Applying Fourth Industrial Revolution

Guideline 03: Creating business responsiveness through Industry 4.0: Organizational agility entails the proficiency in dealing with marketplace uncertainties via rapid responses in transforming certain opportunities into novel products and services. Organizational agility as a consequence of applying fourth industrial revolution can bring enhanced long-term organizational performance as the vertical integration of the networked manufacturing systems i.e. the combination and hierarchal levels of organizational value creation can cut down the time take to meet the demands of clients[5]. Inventive and customized products according to customer requirements [14]can be economically manufactured via the smartly linking various organizational sub-systems in the self-adjusting and de-centralized structure.

Guideline 04: Bringing out efficiency in businesses and improving effectiveness: An efficient and effective organizational performance ensures the survivability of an organization in the marketplace. The resource-based view is the basis of organizational efficiency which entails the development of a dynamic capacity to correct, become accustomed, incorporate and reconfigure proficiencies in organization inside as well as outside to generate further similar inputs. Organizational effectiveness entails the extent of an organization's awareness of its goals. The extent to which integrations are implemented in fourth industrial revolution leads to the creation of the organization's competitive advantage [5]. Hence, managers need to establish Key Performance Indicators (KPIs) for monitoring organizational efficiency and effectiveness throughout the implementation of Industry 4.0 because such KPIs are predictive of its success.

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Guideline 05: Using Industry 4.0 to make your customers delighted: Customer experience is pertinent for organizational success. In a classic pyramid model, the interactions in a three-dimensional pyramid with technology at the top suggesting it as the principal element of customer experience. Customers gain further power and control via automatic and computer-based systems prevalent [11]. The perpendicular, flat and end-to-end integrations in the architecture of fourth industrial revolution will increase responsiveness and information availability. Managers can utilize this new information to tactically design service products with unique customer service experience that would delight customers.

Guideline 06: Tactically implementing Industry 4.0 to gain competitive advantage: Old electrical and mechanical products are being transformed by smart products and services by combining the elements of software, hardware, microprocessors, sensors, information-warehouse, as well as linkage to create a new level of competitive advantage that is unreachable by traditional manufacturers [12]. The conventional product-centric organization will move on to becoming service-oriented following Industry 4.0 implementation, thus leading to the opening of an array of new business prospects. Competitively, such smart products will lead to product diversity, customer division, dynamic price-setting, value-added services, and improved customer relationship [13]. Hence, managers are responsible for devising strategies for extracting competitive advantage following the high-end automation and placing the organization strategically in a marketplace to achieve organizational goals.

Guideline 07: Novelty in production through Industry 4.0: New waves of manufacturing innovation are created via advanced technologies linked via Internet of Things, smart manufacturing and artificial intelligence. Such innovations enable an equipment to self-regulate and communicate with other machines and users. A new manufacturing paradigm is created via the automated processes that reduce the need for human involvement and encourage the dynamic communications and control between the shop floor and markets [13]. Hence, the connectivity and flexibility of the smart factory manufacturing system utilizing big data to meet market demands creates a manufacturing revolution with better competitive advantage than old-fashioned manufacturers. The sustainability of manufacturing innovations specifically in the operational, economic, environmental and social dimensions must also be properly managed, which necessitates the significant role of the managers in carrying out in-depth and detailed analyses on the sustainability of each dimension and in developing strategies to achieve manufacturing innovations.

Guideline 08: Making sure the safety and security of products through Industry 4.0:Due to costs of quality internally and externally, product safety is a crucial element for both the retail and manufacturing industries. Product safety throughout the product's lifecycle falls under the responsibility of the stakeholders in the supply chain including the designer, manufacturer, testing labs and retailers [15]. Product safety and quality issues can be mitigated via the strategic implementation of the perpendicular, flat and end-to-end integrations of fourth industrial revolution using information [16]. Product safety and quality management programs fall under the responsibility of the managers who would have to ensure that the data-oriented, automated and self-regulating programs adhere to legal requirements.

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Theme 03: Advantages obtained by implementing Industry 4.0

Guideline 09: Financial &Functional Advantages of Industry 4.0: Process optimization is central to the implementation of Industry 4.0 prior to value creation, which could be explained by the available data on production activities and supply chain. Lesser marketing time and lead times could be achieved as a result of the vertical and horizontal integrations. Market volatility can be better managed leading to improved inventories across all elements due to better supply chain coordination with the use of real-time data. With the smart products' enhanced responsiveness, there will be lesser quality issues, decreased scrap rates, better systems of production and increased quality throughout the process of manufacturing [17]. Continuous improvements to the products' quality are possible with the availability of product life data [18]. Strategies for operational optimization are also viable with the accessibility to market, product, process, operation and maintenance data. Such operational benefits can ultimately lead to economic gains for the organization.

Guideline 10: Advantages of Industry 4.0 in terms of society and environment: The implementation of vertical integration in Industry 4.0 with regards to carbon footprint or emissions data tracking is rigorously monitored and controlled by a specific algorithm hence leading to the reduction of greenhouse gas emissions. Improvements in resource efficiency can lead to reduced wastes and enhanced energy usage[19]. A key component of fourth industrial revolution namely additive manufacturing can reduce the need for physical transport and logistics hence minimizing transportation-related emissions (Magdalena,2016). Meanwhile, transparency in management and decision-making will be a key social benefit [19]. Physically taxing and intricately complex tasks can be handed over to robots. Work-life quality can be improved as tedious production tasks are carried out by smart, self-directed and self-adjusting processes [20]. The success of fourth industrial revolution by its social and environmental terms effects will depend on how the managers decide to measure it.

III. PROBLEMS AND LIMITATIONS

In contrast to other automation solutions or ERP systems in which decisions are centralized, the applying fourth industrial revolution is decentralized leading to the need for drastic organizational restructuring which will affect the organization in all aspects. Typically, the allocation of resources for technological developments will rely on the prevailing level of market competition; a higher competition level calls for lower allocation due to the lower cost-to-benefit ratio. With Industry 4.0, market competition is not an issue because long-term competitive advantage is guaranteed with its technologies.

The achievement of fourth industrial revolution depends on the totality of its implementation, which is a challenge for the managers due to the financial and organizational restructurings as well as the integration of supply chain and coordination involved. However, the thorough vertical, horizontal and end-to-end integrations in Industry 4.0 offer long-term benefits. Employee acceptance of the technology could pose a major hindrance to its implementation. Radical organizational changes may cause resistance among the trade unions [21] particularly if information about Industry 4.0 was not properly disseminated, or if the initial implementation phase was not convincing enough. Hence, managers need to address the doubts of the employees and the trade unions.

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The implementation of Industry 4.0 requires employees to be flexible, tolerant to ambiguities, motivated to learn, strong under pressure, and sustainability-oriented [8]. The challenge lies in finding employees with such qualities and in training existing ones to hone such skills. The management of human resources is also a key determinant of the success of Industry 4.0. As the technology is made up of socio-technical systems, the joint optimization of these systems is crucial [22]. Hence, managers should incorporate the theory of social-technical systems in each integration phase. Managerial people must also be cognizant of cyber-security threats as this technology involves the digital networking of people, products and machines whereby standardization is developed transparently via the closely-linked smart data processing, digital value-added services and business processes.

IV. CONCLUSION

The implementation / application of fourth industrial revolution is a major challenge for managers as the technology is still in its infancy, which means that there are yet any considerable guidelines in the form of case studies or success stories to fall back on. In this current study, the guidelines, concerns and limitations presented are all based on academic articles. The guidelines are generic enough to be used by all managers in the implementation of Industry 4.0. Basically, the key step is to determine organizational readiness as substantial loss in terms of effort and funds can be avoided if proper initial assessments have been carried out. The ten identified guidelines can be utilized strategically to gain the most paramount benefits of Industry 4.0. In terms of limitations, this study had only used information derived from a limited number of databases. Secondly, it had only considered literatures written in English and ignored those in other languages even if they may be relevant. Hence, future studies could consider incorporating works written in other languages.

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