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The Initial Impact of the Fourth Industrial Revolution on the Maritime Intellectual Capital

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ABSTRACT

This paper aims to highlight the concept, drivers, and applications of the Fourth Industrial Revolution (4.0 I.R). Concepts of intellectual capital, human capital and knowledge economy are well defined with a broad explanation of role of each one of them from the maritime industry point of view. The descriptive method is used to review number of Arabic and English scholars and to determine the knowledge gap. The main outcomes of this study show that the rate of transformation in ports is considered as a phenomenal with the advent of new technologies in the era of the 4.0 I.R that driven by an exponential rate of technological and economic changes, as well as there is a shortage in the supply of marine officers worldwide. So, to overcome this issue interactive and collaborative relationship between maritime academies and the industry should be enhanced further.

Keywords: The Fourth Industrial Revolution (4.0 I.R), Intellectual capital, Human capital and GMP.

1. Introduction

The concepts of knowledge economy and human capital are among the most valuable concepts or assets in the twenty-first century because they represent scientific forces capable of making fundamental adjustments in our lives. The fundamental feature of the global economy in the twenty-first century lies in the ability to perceive economic value knowledge with the aim of enhancing competitiveness by supporting the formation of intellectual capital in institutions of all kinds and their names, as well as successive innovations in it. This means, the knowledge's resource has become the necessary capital for the innovations, and thus investment in human has become an important source of quality sources that can achieve a sustainable economic growth, the human being is the common denominator for all components of sustainable development, and that the accumulation of human investment increases the work of the engine in order to achieve the goals of sustainable development, and to improve its indicators. Hence, interest in the development of human capital guarantees the existence of continuous scientific and technical innovation with the aim of providing new products, whether in the form of goods or services, or even just contenting with improving existing products or services.

In addition, the importance of human capital is increased throughthe use of the applications of the 4.0 I.R which was started a few years ago, it leads to generate a new competitive advantage. It has

stimulated human to more innovations depending on these applications, in turn, human benefited from the 4.0 I.R by improving the productivity of all worksites and employment, parallel with reducing production costs, as the applications of the 4.0 I.R represented by the Artificial Intelligence (AI), Internet of Things (IoT) and drones. The latter, in particular, has contributed to create safer work environments than before, and led to improve the level of quality in the work environment also.

According to Talal Abu-Ghazaleh International Group report (2019), it forecasts that the volume of global payments on the AI to reach an amount of 77 US billion dollars by 2022, and up to a trillion US dollars by 2030, due to the increase of global population, especially in the youth category which will affect the process of obtaining jobs. The World Bank Group (WB) estimates the world population by 2030 at about 8.3 billion, while the age group (range) of the Middle East population will be between 15 and 25 years, which constitutes by 28% of the global population, or equivalent to 168 million.

The entry of the internet and then some applications of the 4.0 I.R to the maritime industry as the major component of logistics and supply chains (SC) had contributed to raising the levels of safety in the seas and oceans through using of the IoT and drones. Meanwhile, the total number of seafarers exceeded 1.600 persons at the end of 2018, while the human error (human factor) onboard ships have cost more than a

billion US dollars for the same year which equivalent to 67% of total causes of maritime accidents (Wanis, 2019).

2. STUDY DEFINITIONS

Generally, this paper aims to achieve two main objectives; highlighting the concepts, drivers and the current applications of the 4.0 I.R, as well as the concept of human, intellectual capital and knowledge economy. Parallel to this, it highlighting the role of human and intellectual capitals and knowledge economy followed by the changes that already occurred on the intellectual capital with the advent of the 4.0I.R. In so doing, this section to provide a number of definitions that related to the study's content.

2-1 Human capital

"*It is an indicator of the economic value of human skills which consists of the knowledge, skills, and health capabilities that people accumulate throughout their lives, enabling them to exploit their potential as productive or creative individuals in the society"*. Hence, the promotion of individual human capital is necessity, because it considered as the key component for productivity, economic and social development (Mansour, 2019).

2.2 Intellectual capital

It is known as "*a set of knowledge, experiences and achievements those individuals have achieved in order to contribute to the development of their societies, and even the entire world".* It necessarily means that the knowledge that can be transformed into

values or profits. In other words, the economic value of a number of intangible assets that the society can be obtained with these assets. It consists of human capital, structural capital (internal), relationship capital (external), and innovation capital (Mitchell, 2010).

2.3 Knowledge economy (knowledge-based economy)

"*It is an economy when knowledge is representing or considered as the basic element of production and driving force for wealth creation*". As the focus shifts from raw materials and capital equipment to knowledge, information and scientific research centers and development of creativity and innovation. Compared to the industrial economy, the knowledge economy is described as an economy of capital rather than infrequent economy and it is not governed by obstacles of time or space (Daugherty et al., 2018).

2.4 The Fourth Industrial Revolution (4.0 I.R)

According to Klaus Schwab (2015) who introduces the term of the 4.0 I.R for the first time in the World Economic Forum in the year of 2015 is *"a combination of the technologies that preceded it in the Third Industrial Revolution that lines between physical, digital and biological fields and driven by a number of engines, and represented by advances in genetic engineering, nanotechnology, physical Internet, 3D printing, crypto currencies, IoT, AI and robots"*.

3. LITERATURE REVIEW

This section is devoted to review of the literature that structured in the following manner; firstly, it seeks chronologically the relationship

between human skills and the 4.0 I.R applications, followed by the relationship between the 4.0 I.R and shipping, ports and vocational education, then the relationship between the 4.0 I.R and knowledge capital investment strategies, followed by the components of intellectual capital and its relation with the knowledge capital. Finally, gap analysis is furnished at the end of this section.

Human is the core of knowledge, while the knowledge is the engine of productivity and economic growth, it focuses on the role of information and technology and it teaches how economic performance is. The increased speed in the creation and dissemination of knowledge has led to the rapid spread of modern technology and efficient production, as well as the increased probability of leaps that have led to increased competition at the global level. The development of rapid knowledge, on the other hand, requires lifelong training, a higher level of scientific and technological employment than before, and the need to acquire a better education has become urgent for workers. Higher wages will be directed towards workers who are able to deal with encoded information and technological knowledge rather than manual labor or physical effort.

Historically, technology has had a profound impact on the employers' skills. Technical skills, which known as the hard skills are the only skills necessary for career employment. Today’s workplace, however, is showing that technical skills are not enough to keep individuals

employed when organizations are right-sizing and cutting positions (James and James, 2004). This is because soft skills are critical for productive performance in today's workplace. The current and future business leaders are emphasizing the development of soft skills (Nealy, 2005). Although, technical skills are a part of many excellent educational curricula, the soft skills need further emphasis in the university curricula so that students learn the importance of soft skills early in their academic programs before they embark on a business career (Wellington, 2005).

As the 4.0 I.R gathers pace, innovations are becoming faster, more efficient and more widely accessible than before. Technology is also becoming increasingly connected withthe physical and biological realms, while the new technologies are enabling societal shifts by having an effect on the economics, values, identities and possibilities for the future generations. Therefore, the 4.0 I.R technology clusters mean number of technologies which include;the 3D printing, advanced materials, AI, advanced robotics, drones, autonomous vehicles, block chain , IoT, and distributed ledger, geo-engineering, neuro-technologies, advanced sensor platforms, virtual, augmented and mixed reality, new energy technologies (capture, storage, and transmission) and bio-technologies (WEF, 2017). So, to enable younger and upcoming generations to take advantage of the 4.0I.R. we need to shift emphasis away from growth learning, knowledge

consumption, and conformity, and build the huge capacities for innovation, creativity, and collaboration.

In contrary, Elias V., (2019) mentioned that there are some high-value skills cannot achieved by the AI and robots and the human still has an advantage, such as leadership, creativity, emotional intelligence, discretionary judgments and knowledge transfer, and will continue as an advantage for the human. These skills, however, always are required by employers and businesspersons.

So far, the maritime transport sector is part of a global market that has developed a global governance system based on the historic background of the 'Mare Liberum' principle. This system incorporates instruments such as the ILO's Maritime Labor Convention (MLC, 2006) and the IMO's Convention on Standards of Training, Certification and Watch keeping for Seafarers (STWC, 1978). However, the STCW Convention was the first international convention to set international standards for seafarer training, certification and watch keeping. However, there is a number of limitations to this convention in its first iteration and subsequent major revisions in 1995 and 2010 have sought to align the standards with the evolving nature of industry, law and socio-cultural dynamics.

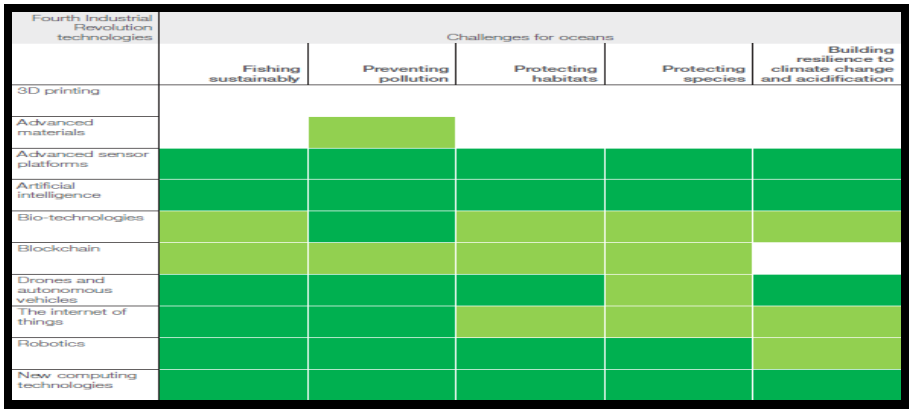

Figure.1 Development level of 4.0 I.R technology applications that address challenges for oceans

(Source: WEF, 2017)

Despite the continuing improvement in the international legislative framework, there have always being attempts in different jurisdictions to go beyond the requirements of the STCW 1978 Convention. Nowadays, there is an internationally compliant with seafarer education and training through focusing on the technical competencies and the affective competencies that required by the STCW 1978 Convention. Further, it outlined the professional competency standards to enhance the safety at seas.

Major companies do not have traditional or infrastructure or physical assets that are working to create values by technology employment in order to attain interconnection between people, products and services. Moreover, gaining the maximum profits by the productivity, itwill lead to achieve a flexibility which known as "Open Talent Economy ". In this kind of economy, companies arereplacing the permanent or

traditional employees or long-term jobs by the talented people on time-based jobs bases.

From the shipping perspective, there are 93,161 vessels with a total deadweight tonnage of 1.86 billion tones in 2018, transported in excess of 83% of world trade (UNCTAS, 2018). The Athens Declaration of the European Union (EU) Member States for instance, acknowledges that 75% of the EU imports and exports depend on the maritime transport. Oxford Economics (2015) outlines the importance of the EU shipping industry, it has a total impact on the EU GDP of 147 billion Euro, and on the labor market with 2.2 million jobs. The EU controlled fleet represents 40% of the world tonnage, and grew by 70% from 2005 to 2014.

On the other hand, the maritime industry has not escaped the 4.0 I.R sub-sectors, such as; shipping, port operations and shipbuilding that have gotten into the groove of going digital and surf with the wave of the 4.0 I.R. Some shipping companies are already using the real-time information to send and receive data about transported cargo by their vessels. These days, virtual, crewless ships are being tested, while ships with E-navigation features such as; electronic charts and technologically driven environmentally friendly characteristics are common (MFI, 2018).

Furthermore, from the ports perspective, the ports use IT extensively to plan their container loading and offloading onboard ships and to

track containers in the port yards. Remotely controlled, autonomous vehicles and robotics are increasingly used in repair and maintenance work at yards in order to check the integrity of vessels and offshore structures. Added to this, the world's top shipyards use sophisticated computer aided design software to design ships and share draft designs through the cloud with ship owners, consultants, maritime equipment and systems manufacturers, and classification societies (MFI, 2018).

From the vocational education and training perspective, there are many consultants and policy reports address that the 4.0 I.R is in increasingly complex and interconnected world that characterized by the rapid development of technology and science, it becomes self-evident that education and training should prepare us for this context. This is a context in which creativity, innovation, reflexivity, entrepreneurship, flexibility and adaptability are deemed pivotal, as are a range of soft skills.

In this vein, the International Association of Maritime Universities (IAMU, 2020) has sought to formulate a vision for a Global Maritime Professional (GMP) which described as: *"An individual who is a professional in the maritime industry and who is equipped with all the relevant technical competencies relevant to their specific operational role in the industry and as required by international requirements with high level academic skills including logical and critical thinking*

and who – in addition to their technical competency – exhibits a high level of professionalism and ethical behavior, human relations skills, emotional intelligence and multicultural/diversity awareness and sensitivity".

Added to this, such individual exhibits a significant leadership skill and is able to optimally work with teams and also take personal initiative. They additionally exhibit a high sense of environmental consciousness and the need for sustainable practices and have an excellent grasp of contemporary issues affecting the maritime industry. The GMP learning outcome requirements categorizes into four levels or tiers: A, B, C, and D. The GMP Tier A addresses the requirements of the operational level competency in the maritime industry together with a first academic degree. The GMP Tier B addresses the requirements of management level competency in the maritime industry together with the academic degree requirements of Tier A. While The GMP Tier C addresses the requirements of management level competency together with a postgraduate academic degree. The GMP Tier D addresses the requirements of management level competency together with an advanced postgraduate academic degree (IAMU, 2020).

In terms of human capital development, the agile workforce is an organized and the dynamic talent that can quickly deliver the right skills and knowledge at the right time, as the business needs dictate.

Thus, an agile workforce is a necessity in a growing automation scenario. However, the attributes of the agile workforces are; adaptive, flexible, developmental, speed, collaborative, competent and informative (Human Resource, 2018).

On the other hand, there are some reluctant and hesitate contributing to be up to speed with the hi-tech world, such as; conservative business strategies, lack of understanding about the 4.0 I.R. and its opportunities, as well as the values it can bring. Added to this, fear of technologies, lack of regulatory or policy push, lack of financing and even reluctance to spend. Some do have valid reasons but there are those who are apprehensive about the changing world (MFI, 2018).

They veer towards an individualized notion of a 'choice biography' whereby this becomes a project of the self, precluding the manner in which it is set within a wider structural context that features antagonistic relations between the interests of capital and labor. This arises from the consequence of job polarization and hollowing out of middle-level jobs (Avis, 2018).

As mentioned above, Schwab (2015) is the first person who introduces and defined the 4.0 I.R concept. He claimed that the 4.0 I.R must achieve the following: (i) efficiency: that can be achieved by savings of raw materials and energy, (ii) productivity: which achieved through the intelligent technologies that are more productive, (iii) flexibility: that can be achieved by using the cyber-

physical systems, (iv) individualization on demand: that can be achieved exclusively through integration of customer through the network (cyber-physical systems) and, (v) decentralization: which lead to the faster and data-driven decision-making.

Hlali, (2011) in his study illustrated the concepts of knowledge, knowledge management and intellectual capital in the institutions, especially in the higher education institutions, as well as the different methods and tools which can be used to evaluate the return on the investment in intellectual capital in the higher education institutions, while Hwajrah, (2010) clarified the relationship between the knowledge capital investment strategies and performance of the Jordanian insurance companies. He found a strong and positive correlation between investment strategies in the knowledge capital and the competitive performance of insurance companies under the study.

Mitchell (2010) in his study "a model for managing Intellectual capital to generate wealth" clearly illustrated the components of the intellectual capital, they are the human capital, innovation capital, structural capital, and relationship capital. He clarifies the effect of the human capital on the performance. In other words, human capital strongly affects the structural capital. Thus, the components of intellectual capital all together contribute to distinct firms and organizations in the market.

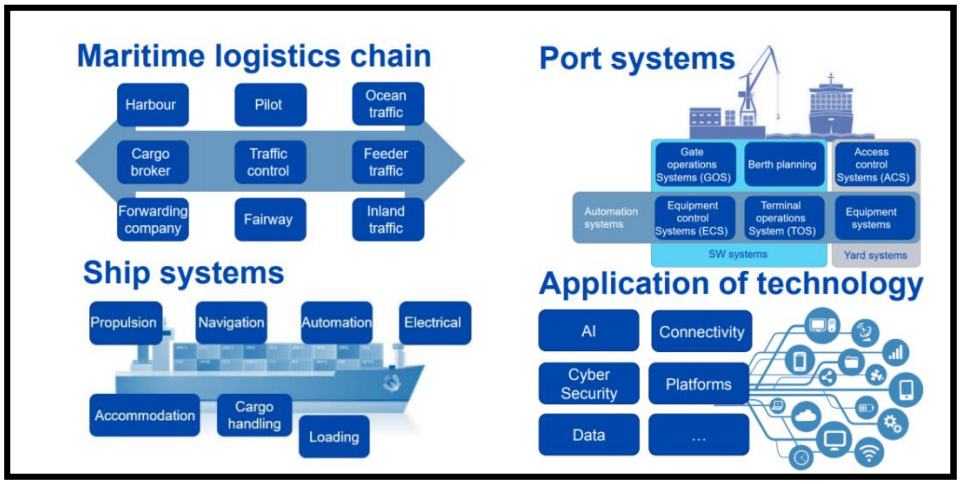

Figure.2 The 4.0 I.R. applicationsin the maritime industry
(Source: Tran, 2018)

So far, every year many students intending to become seafarers when graduate from the maritime institutes. However, the seafarer selection process of the national shipping companies are based on; crew costs, knowledge and skills, ability to communicate, physical and psychological attitudes, and conditions of seagoing service. Similarly, Wu and Winchester (2005) concluded that the seafarers should be selected according to manning cost, legal constraints of the recruitment country, and their onboard management experience.

Lobrigo and Pawlik's study (2015) indicated that the main decisive factors for maritime labor demand including; total crew costs, restrictions on the nationalities of employed seafarers, technical and cultural competence, and the quality of seafarers as influenced by maritime education and training. Wang (2016), on the other hand,

suggested that the main influential factors for seafarer recruitment including; loyalty, wages, seafarer cooperation, efficiency, and better education and training.

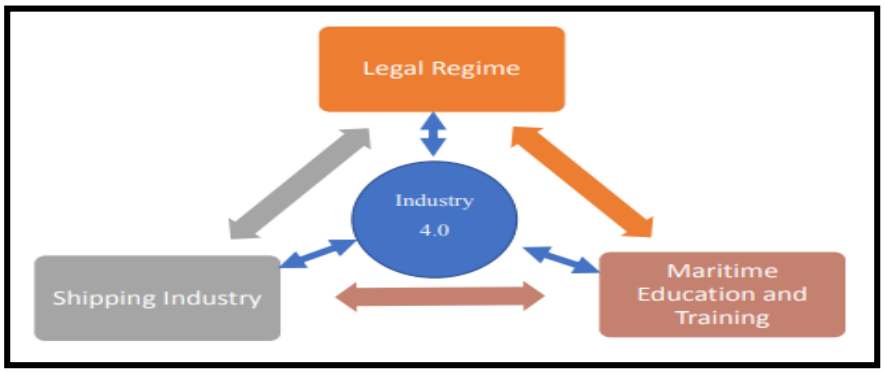

Figure.3 The relationship between 4.0 I.R and maritime sector

(Source: Tran, 2018)

As shown in the Table.1, the global supply of seafarers has increased between 2005 and 2015, with both numbers of qualified marine officers and ratings to the internationally trading world merchant fleet. The number of marine officers was reported to have increased by 34% between 2005 and 2010, and by 24% between 2010 (BIMCO, 2016).

Table.1 The global supply of seafarers 2005-2015

Rank	**2005**	**2010**	**2015**
Marine Officers	476,000	637,000	790,500
Ratings	585,600	747,000	754,500
Total	1,062,000	1,384,000	1,545,000

(Source: BIMCO, 2016)

The report also indicates that the forecast growth in the world merchant fleet till 2025and its anticipated demand for seafarers, it will likely continue the trend of an overall shortage in the supply of marine officers. This is despite improved recruitment and training levels and reductions in officer wastage rates over the past years. Table.2 illustrates supply-demand balance forecast for marine officers by year of 2025.

Table.2 Forecastsupply-demand for marine officers by 2025.

	Marine Officers	Ratings	Total
Supply	774,000	873,500	1,647,500
Demand	790,500	754,500	1,545,500
Shortage/Surplus	—- 16,500	—119,000	—102,500
%	2.1%	15.8%	6.6%

(Source: BIMCO, 2016)

With respect to above review, there are no previous scholars dealt with the impact of 4.0 I.R. on the maritime work force nor marine education. Thus, this study is considered as an attempt to fill this gap.

4. METHODOLOGY

The moral, cognitive assets or intellectual capital (the tangible) are used interchangeably as synonyms for one thing. Accountants, for example, tend to use the term tangible assets, while the economists prefer to use term resources or knowledge assets, and administrators prefer to use intellectual capital instead. Accordingly, this paper aims to brief knowledge aspects related to the human capital and the initial

impact of the emergence of the 4.0 I.R and its applications through reviewing number of Arabic and English works as described in the previous section using the descriptive method/analysis.

5. DISCUSSION, RESULTS and POLICY IMPLICATION

The operating environment in the ports considerably changed during the last few decades. The private international operators have taken a bigger role in operating and managing of port business. Therefore, the technological development has been rapid in the shipping and port industry which including; an increase in the vessel size, share of containerized cargo and automation. These days, handling cargo is much faster than before and due to the globalization, more variety of containers are being handled in view of their geographical origin and destination. These developments have posed new challenges for port workers. Due to automation, the work requires less physical strength. In addition, the work is increasingly being done in small groups without much supervision. The number of handled cargos per worker has increased and the variety of the origins and destinations of the cargo too have amplified.

The shipping industry is evolving rapidly, and the maritime industry in the future will be driven by three interrelated and reinforcing trends: (i)The maritime industrial internet which merges big data with big iron, integrating cloud-based analytics with industrial machinery, resulting in greater efficiency and reduced downtime, (ii) The global brain, the collective the intelligence of human beings across the globe

integrated by digital communication, resulting in crowdsourcing, open collaboration, and a much faster pace of innovation, and (iii) Advanced manufacturing which weaves together design, product engineering, manufacturing, supply chain, distribution and servicing into one cohesive intelligent system, delivering greater speed and flexibility at lower costs (Mansour et al., 2019).

In fact, technology has changed the nature of several educational processes. Online platforms and ICT tools for instance, have helped to take higher education to millions of deserving students in the far-flung areas who would otherwise have no access to the university education. Recently, with the Covid-19 (new Corona-virus) pandemic causing widespread panic, many areas of one's daily life such as education and work are being adversely affected. Precautionary measures taken by governments have forced schools, universities, and offices to lockdown.

Thereby, online learning is set to have a transformative long-term impact on the educational approaches in both anticipated and unforeseen ways. Added to this, the higher educational institutions are already capitalizing on the growing trend of education and training online by offering their own E-learning courses, and teachers have had to become more tech to adapt to this new learning environment. Meanwhile, combining online educational materials with traditional classroom methods are here to stay. Despite this, internet

infrastructure issues should be carefully considered before adopting E-learning (Across limits, 2020).

To this end, the 4.0 I.R technologies and applications are already taking shape and has immense potential to change the life of millions of people globally. It is about the digitalization of data and information exchange, advanced automation and robotics, through using Cyber-Physical System and AI. It is the convergence of operational, productivity and information tools, digital data exchange, global infrastructure connectivity, and edge computing (Mansour et al., 2019).

The appearance of the 4.0 I.R. brought number of advantages including; increases productivity, reduces production costs, creates a safe work environment and produces very high quality of commodities and services. In contrary, it has some impacts that including; skills insufficiency because the required new skills of workers did not known before, threats of robots to many areas of life because it will replace many jobs, as a result many employees will lose their jobs (Yehia, 2020).

According to the McKinsey Global Institute study which was conducted in 46 countries and covers more than 800 jobs that bout750 million employees will lose their jobs around the world and will be replaced by robots in year of 2030, added to this, an economic recession is highly potential which leads to a global economic war.

Furthermore, emerging technologies will automate most of the human resources processes. Both, organization structure and leadership style changes would be required for the human capital. The 4.0 I.R. is an increasingly complex and interconnected world, characterized by the rapid development of technology and science, it becomes self-evident that education and training should prepare us for this context. This is a context in which creativity, innovation, reflexivity, entrepreneurship, flexibility, and adaptability are deemed pivotal, as are a range of soft skills (Daugherty and Wilson 2018).

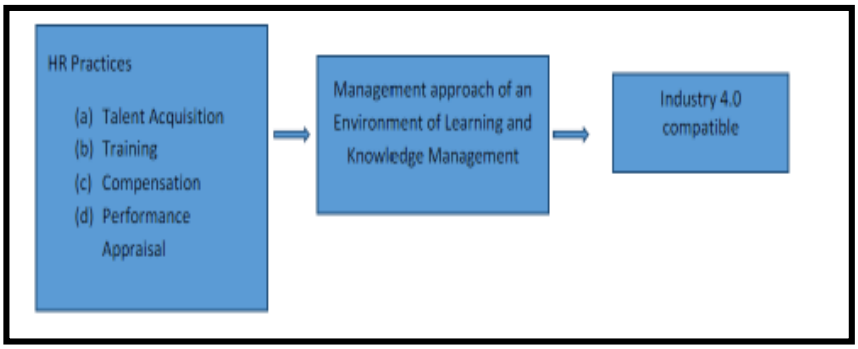

Figure.4 Skills set strategy in the 4.0 I.R
(Source: Shaw, 2018)

6. CONCLUSION

Knowledge is an essential characteristic of human society through which profound transformations have taken place in almost every aspect of life. Knowledge is undoubtedly one of the important achievements of both economy and society. This paper, however, has addressed wide-range literature on the human capital within the 4.0 I.R concept. It illustrated the relationship between technology and

human skills which is a complex relationship rather than technological unemployment. Indeed, it is important to recognize that the new technologies such as the 4.0 I.R. applications and digitalization are entwined with the human or social relations.

About83% of world trade is transported by the international shipping and the world has faced the globalization, exponential technological development, intensification, and flexicurity. These trends, evidently, are affecting the maritime labor market.

In this regard, the innovations of the 4.0 I.R. has a positive impact on the maritime industry, as it creates new possibilities for all, which including; stakeholders, governments, and market, Innovation and technological developments such as the digital transformation and automation in the shipping and port business can have wide ramifications on the workers and human resources managers. However, port organization is most suitable to be revolutionized technologically. However, the rate of transformation in port industry is considered a phenomenal with the advent of new technologies in the era of the 4.0 I.R. because the rate of change in technological and economic is exponential, and it widening the gap between labour market and education. The robots, on the other hand, will take over thousands of routine tasks and will eliminate many low-skill jobs in the advanced economies and developing countries as well.

In a similar vein, technology will create more opportunities, paving the way for the new and altered jobs, increasing productivity, and improving the delivery of public services. Many jobs today, and many more in the near future will require specific skills such as; a combination of digital and technological know-how, problem-solving, and critical thinking, as well as other soft skills such as perseverance, collaboration, empathy, and entrepreneurial skills.

Silos et al., (2012) argued that due to advances in the maritime technology, increased safety requirements, environmental protection and other factors, while some new responsibilities have fallen on seafarers, requiring them to have advanced professional qualifications in order to improve the operating efficiency levels of port and shipping.

One important conclusion from this paper that supply of seafarers is tightly associated with the scale of the world fleets which is linked with world economy‘s climates. Consequently, the current maritime manpower situation and future outlook indicate that the maritime industry and relevant stakeholders should not expect there to be an abundant supply of qualified and competent seafarers in the future without concerted efforts and measures to address key manpower issues.

On the other hand, the condition of maritime education and training with regards to the maritime industry is done in isolation and

fragmented. The concept of GMP, however, is intended to meet the envisaged needs of maritime industry and a rapidly evolving educational and career context while catering for the professional development aspirations of individual seafarers. This has to be relooked objectively as it is necessary to bridge the gap between the human resources development and up-to-date technological requirements to ensure efficiency, effectiveness, and timeliness in maritime operation which will, in the long run, result in worldwide cost saving. Moreover, the interactive and collaborative relationship between maritime academies and industry should be enhanced further.

Another important conclusion from this paper that due to the growing shortage of seafarers which become a global concern, this study strongly recommends that there is a great need for scientific research in the maritime field that represents the role of human capital, as well as, in order to encourage more decent employment conditions for seafarers.

Consequently, there is a question raised from this paper *"due to the pace of changes, in future will technology replace people, and how will it impact on our lives and the ways of work in ports and onboard ships?"*

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