A PROPOSE NEW HUMAN CAPITAL DEVELOPMENT FRAMEWORK IN LOGISTICS AND SUPPLY CHAIN INCORPORATING INDUSTRY 4.0

ABSTRACT

When Industry 4.0 technologies are utilized in logistics practices it creates a Logistics 4.0 environment, and the key to successfully implementing Logistics 4.0 practices is the human capital of the logistics industry. The human capital of the logistics industry was found to be classified into four major categories, namely; operative, supervisor, management and government. This study aims to develop a new human capital framework that guides the logistics industry towards successful implementing and managing Logistics 4.0 practices. The significance of this study is to utilize a new framework to fill the gap between current basic logistics practices into Industry 4.0 practices. An PRISMA literature review technique was used thoroughly reviewed and analyzed in order to create the Logistics 4.0 human capital development framework in a manner that satisfies the four major categories of logistics human capital. A combination of the previous version Business Logistics Management (BLM) framework and Industry 4.0 elements creates a new human capital development (HCD) framework in logistics and supply chains. Finally, a comparison study between both BLM and HCD has been highlighted in the creation of each category of the framework.

Keywords: Industry 4.0; Logistics 4.0; Human Capital; Logistics Skills; Supply Chain; Business Logistics Management

1. INTRODUCTION

Nowadays, the world is governed, shaped, and controlled by both technologies and digitization. Industry 4.0 causes a disruption to all industries, forcing all governments to consider making use of such technologies in order to keep a competitive stand in the world market. That being said, the process of transitioning to Industry 4.0 is sensitive to numerous factors, e.g., type of industry, government regulations and workforce. This study focuses on the logistics industry and how it can be optimized to reach Industry 4.0 standards (Gumzej, 2022). Moreover, this study aims at introducing a theoretical framework that enables a constructive transition of the logistics industry to Industry 4.0 standards (Logistics 4.0) through human capital development (HCD).

Industry 4.0 is the presence of automation and decentralization along with interdependence control (Qin et al., 2016). Consequently, its implementation and growth require less old-fashioned manufacturing workforce and more modernized one. The biggest drivers of Industry 4.0 are technology developers as they provide the biggest two main elements of Industry 4.0 and they are; Internet of things and Big data (Umachandran et al., 2019). But Industry 4.0 is an exceptionally large concept and involves many practices that are evolving rapidly, hence the need to summarize it. The amalgamation of four elements were found to give a brief and general representation of the Industry 4.0 concept, and these elements are; Internet of thing (IoT), Big data, Cyber-physical systems (CPS) and smart factory (Hofmann & Rüsch, 2017). IoT utilizes artificial intelligence, big data and the cloud to achieve a continuous connectivity between all elements of the industrial practices and enables immediate responses when needed. Big data is the key for autonomy as everything in Industry 4.0 operates on or generates data. This data is exceptionally large, comes in a vast variety of forms, grows and shifts very fast. Big data can come structured, i.e., easy to draw value from, semi-structure, i.e., not defined enough to draw value from it, and unstructured, i.e., raw and large data that give no value unless it is processed. CPS is defined as providing control over the physicality of the industrial operations by integrating computational and network solutions, e.g., IoT and Big data. With special elements such as; actuating and sensing devices, control processing solutions and communicative machines and devices. Smart factory is the incorporation of all previously mentioned technologies in order to optimize the efficiency of the industrial and reduce traditional labor to the minimum (Barreto et al., 2017; Hozdić, 2015; Shafiq et al., 2019).

The logistics industry represents the perfect environment for the employment of Industry 4.0 practices (Wang, et al., 2020). Especially since logistics is embedded in almost all industrial, health and food sectors and practices. A vast number of technological solutions that has the potential to revolutionize the logistics sector and bring the Logistics 4.0 era are present today. These technologies can disrupt all parts of the supply chain industry including its economical contribution (Wang, et al., 2021). The fact that the logistics industry is a form of international connectivity between different countries represents an opportunity to encourage the spread of Industry 4.0 and Logistics 4.0 rudiments world widely (Gumzej, 2022). Some of the technological solutions that enable logistics 4.0 practices and are employed today such as; Automation, Robotics, Blockchain, IoT, Big data, Cloud computing, 3D printing, Artificial intelligence (AI) and Augmented reality (AR) (Barleta et al., 2019; Bhattacharyya & Mandke, 2021).

The most widely used technologies in logistics practices are automation and robotics as both are correlated to one another (Bhattacharyya & Mandke, 2021). The use of robots for picking up and arranging goods and automated trucks and boats are usually present in warehouses and ports with standardized efficiency. Cloud computing enables remote access to physical and technological parts of the logistic practices with the help of outward telecommunication services providers. 3D printing creates polymer elements for local uses which in return reduces time and cost of transport. AI in logistics is used for forecasting and predictive demands, to optimize production in terms of satisfying the demand and saving time and money. AR is a very useful tool in warehouse practices, it helps with selection processes, controlling the quality of services and optimizing routine jobs like; packaging and organizing goods in the warehouse (Barleta et al., 2019; Galli, 2021). Blockchain technology is a circulated database that is embedded in a shared network and consist of sequential blocks that record past transactions and safeguards information using public-key cryptography that is only verifiable by the public network community (Francisco & Swanson, 2018; Seebacher & Schüritz, 2017; Wang, et al., 2021). Blockchain enables tracking of goods, information and transactions in a secure manner, subsequently, time, costs and error are reduced and work efficiency is increased (Tijan et al., 2019; Wang, et al., 2021).

The human capital term was first introduced by Theodore W. Schultz back in 1961 and then in 1964 Gary Backer introduced the Human Capita Theory, which states that the wages and benefits of employees should match their educational and expertise levels (Wuttaphan, 2020). The human capital is the door to implement Logistics 4.0 practices since the logistics industry like any other is governed by its human capital starting from its top management all the way to its operatives. It was found that the responsibility of preparing an equipped human capital in logistics falls in the hands of logistics employers and managers (Ellinger et al., 2012; Hult et al., 2006). Hence, the objectives of this study fall diligently on answering the following research questions;

Q1: How can we fill the gap between the current logistics practices and Industry 4.0 practices?

Q2: What makes the human capital development a key enabler to shrink or eliminate the gap between the current logistics practices and Industry 4.0 practices?

In this study, a theoretical framework that utilizes human capital development is established. This framework aims to fill the gap between basic logistics practices to globally standardized Logistics 4.0 practices. This paper makes the following contributions:

1. This research uses the previous version of the Business Logistics Management (BLM) framework as well as Industry 4.0 aspects to establish a new human capital development (HCD) framework for logistics and supply chains.
2. The purpose of this research is to provide a theoretical framework to assist logistics human capital in effectively administering and managing Logistics 4.0 practices in order to bridge the gap between present fledgling logistics practices and globally recognized practices, i.e., Logistics 4.0.
3. In addition, this research has added to the body of information in the literature, which may be expanded in numerous ways of research and practice in the future.

In section 2, literature review is given. Section 3 provides human capital development theories. Methodology is highlighted in section 4. Synergy of Industry 4.0 and human development skills in logistics are expressed in Section 5. Section 6 discusses the proposed framework, and finally section 7 concludes the paper.

2. LITERATURE REVIEW

This section describes the industrial revolutions, starting from the first until Industry 4.0. In additions, it provides recent implementations of Industry 4.0 practices in the logistics industry. Moreover, it discusses the human capital of the logistics sector and gives a hierarchal view of it.

The first industrial revolution was the emergence of the steam engines, which was back at the end of 18th century. It represented the transition from agriculturally dependent economy to an industrial economy. It enabled the creation of different machinery that was driven by water and steam. The second industrial revolution occurred at the beginning of the 20th century and involved the use of machines powered by electricity and accompanied with diverse mass production with the assistance of labour organization. By then, the industrial activities grew more and more complex until the arrival of the third industrial revolution, which started in the beginning of the 1970s. it involved the use of computers, primitive automation practices and electronic and Information Technology (IT) solutions. The fourth industrial revolution was first announced in 2011 in Germany during the Hannover fair. It is based on the information communication technology (ICT) vision of 2020 (Buhr, 2015; Umachandran et al., 2019).

2.1 Logistics 4.0 implementation

Hofmann & Rüsch (2017) developed a theoretical model for implementing logistics 4.0 practices. They stated that logistics 4.0 can be classified into two modes, namely; physical supply chain and digital value chain. The physical supply chain includes all autonomous systems that achieve the logistics practices (e.g., transport and orders handling and processing). While the digital value chain mode includes all the data that achieve the Logistics 4.0 practices, along with its analytic and processing solutions. These two modes if applied successfully they should achieve the main values for the customers. The first value is the availability of the products and services offered by the logistics facility. The second value is the transparency of the operations and traceability of goods along the supply chain. The third value includes all IT services beyond the basic distribution and physical logistics services.

The main question isn't whether or not Logistics 4.0 will be implemented, but rather when will the Logistics 4.0 technologies be utilized by all countries. In the region of Latin America and the Caribbean, the IoT has an expected annual rate of 27% throughout the duration of 2014 to 2024. The region grew from 14.6 million connected devices back in 2014 and is expected to grow up-to 160 million by 2024 (Barleta et al., 2019). In the Gulf Council Cooperation (GCC) region reports gave evidence of logistics establishments implementing Industry 4.0 solutions like; Big data, IoT, Artificial Intelligence (AI) and cloud computing. In UAE for instance, evidence was found pointing to several retail small and medium enterprises (SMEs) utilizing AI solutions in their logistics operations (Abudaqa et al., 2020). Also evidence was found confirming the utilization of Big data analytics, IoT, cloud computing and blockchain in several logistical practices in the UAE (Bvepfepfe et al., 2019; Khan, 2019). In Saudi Arabia reports pointed the use of Big data analytics and AI in logistical activities (Elgendy, 2021; Yousif Alsharidah & Alazzawi, 2020). In Oman, little evidence of logistics 4.0 was found. One study gave evidence of adopting cloud computing technologies in Omani-based logistics. This was realised with the e-government platform, which links the supply chain management at all ends and the government entities (Taderera et al., 2018).

2.2 Human capital of the logistics sector

The UK Logistics skills council defines 10 levels in the logistics hierarchy (see Figure 1) and for simplification purposes (McKinnon et al., 2017) grouped these 10 levels into four main categories, namely; Operatives, Administration staff, Supervisors and Managers. The operatives' category includes all basic operations that don't require logistics or administration skills whatsoever, e.g., truck drivers, forklift operators and warehouse workers and cleaning staff. This category of the logistics hierarchy is subject to elimination due to Industry 4.0 disruption by swapping the human capital with collaborative robots and automated vehicles and devices. The administration staff category includes clerks, customer service staff and all employees that process information and have little to none of the supervisory and management functions. This category is very susceptible to elimination due to Industry 4.0 technologies that achieve the administrative objectives digitally and autonomously.

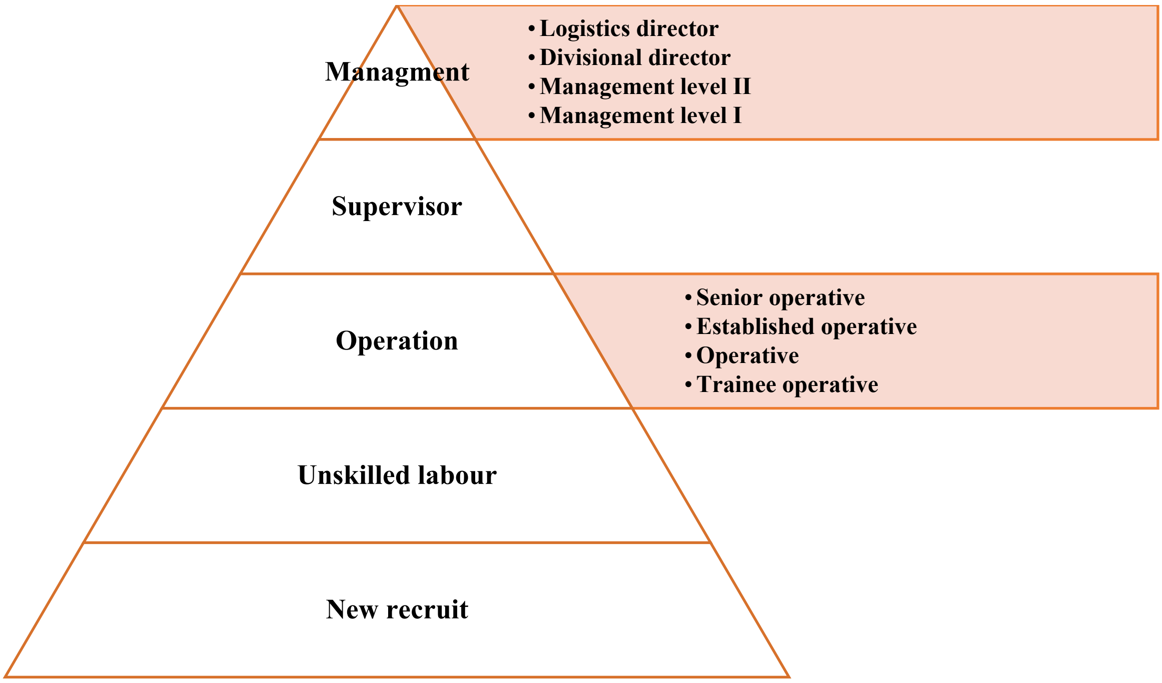

Figure 1. Logistics hierarchy (McKinnon et al., 2017)

The Supervisors' category is the heart of the logistics operations. It includes all ground operations of a logistical establishment, e.g., team leaders. They connect the management commands with the operatives and administrative staff functions. This category is subject to optimization in the Industry 4.0 era. Finally, the managers' category, which includes all managerial staff at the top, mid and bottom management level. This category sets the vision and objects of the logistics facility and strategizes and sets plans for marketing, budgeting and all leadership practices.

In addition, this study claims that the government policy makers who influence the logistics sector are considered a part of the logistics human capital. Literature gave evidence of several governments enhancing the logistical practices through human capital development. Much like the case of Singapore, Dubai and Saudi Arabia, where organizing and assembling nation-wide logistics conferences on skills development and training is very frequent. Also, adopting globally renowned standards for local practices by establishing homebased branches of logistics bodies like; the Chartered Institute of Logistics and Transport (CILT), the Council of Supply Chain Management Professionals (CSCMP) or Bundesvereinigung Logistik (BVL). Much like the case of the Chinese government adopting the CILT certifications. Another example is the UK's "SAFED" program, which provide training for trucks and vans drivers (McKinnon et al., 2017).

3. HUMAN CAPITAL DEVELOPMENT THEORIES

In this section, the authors will provide evidence on the role of the human capital for the industrial and economic development of an organization. Consequently, this section should answer the second research question of this study and provide support to its claim, which is "elevating the logistics industry to reach Industry 4.0 standards is highly dependent on the human capital".

The human capital theory has several definitions, two of which have resonated throughout time and helped many scholars achieve optimization goals. In the first sense, human capital can be defined in terms of education, reaching to the notion that an employee's financial return is directly proportional to their educational level, knowledge and expertise (Gillies, 2017). In the economic sense, the emergence of what is known as "the Endogenous Growth Theories" back in the 1980s, led scholars to the realisation that the sustainability of economic growth of an organization is highly dependent on internal entities such as human capital rather than external factors like technological advancements (Maré, 2006). In any sense it can be concluded that the human capital development theories are a corner stone in the improvement of a firm's resources to achieve increased productivity and enhanced performances. Moreover, the human capital is crucial in maintaining a competitive advantage in the market (Schultz, 1993). When it comes to the effect of the sustainability of skilled human capital on the economic growth of a country Matousek and Tzeremes (2021) used an empirical model to analyse a set of data concerning 100 countries during the period from 1970 to 2014. Their results showed that the rise in human capital has a statistically significant and non-linear effect on the economic growth of the country.

Throughout history, the human capital proved to have a crucial role in the success of the industrial revolutions. One of the earliest evidence of that is the first industrial revolution in Britain, which favoured skilled labours rather than the pre-industrial era that was dependant on artisanal workforce (De Pleijt et al., 2020). Moreover, the second industrial revolution in America, which was the shift from hand manufacturing to machine manufacturing practices, ultimately achieved improved productivity, performance and way of living, and presented a new view of the human experience (Mokyr, 2018). The third industrial revolution brought with it some technological infrastructure (e.g., electricity, fuel engines, factory systems, etc…) that led to the division and classification of workforce specializations, subsequently, the work efficiency was highly increased and the emphasis on education, knowledge and skills was highly strengthened (Gruzina et al., 2021). Nowadays with the constant development caused by Industry 4.0 the role of the human capital grew more complex, relying less on the operational aspect and more on strategizing and decision making to achieve synchronisation between the information, technology and human factor. Wang et al. (2022) found that human factor played a vital role in logistics operations, for example driver shortage could influence both logistics capability and logistics performance. Goffee & Scase (2015) argued that the architecture of an Industry 4.0 workforce comprises of five elements, namely; Strategic apex, Middle line, Operation core, Techno-structure and support staff. The first element “Strategic apex” represent the strategies makers of the organization, the second “Middle line” represents the employees responsible for the flow of data between the first element and the third. The third element “Operation core” are the ones responsible for the basic operations. The fourth element “Techno-structure” are the analysers, such as; project engineers, those provide services that insures the achievement essential processes like production. Lastly, the fifth element “support staff” represent administrative and human resources staff (Flores et al., 2020).

It is evident that throughout history all industrial revolutions were highly dependent on the human capital of the industries that were affected with said revolutions. Hence, the authors of this study emphasize on the role of the human capital in implementing Industry 4.0 fundamentals. Nowadays, global communication and international markets are only achieved through technologies and imposing on all the suitable developments to achieve standards that are in-line with global indices and rankings. These indices and rankings represent the earning of the world market trust, specially in the logistics sector. And at this point arises the necessity of Industry 4.0 practices and how they play a major role in achieving global acceptance. Moreover, Industry 4.0 is all about digitizing all operations to achieve autonomy, efficiency and speed, and these goals are achieved through the use of technologies like; Big data, cloud computing, AI, AR and IoT, that are already invented and available in the market, and all that is missing in nascent industries is the human capital that is capable of employing these technologies in an adequate and efficient manner.

4. METHODOLOGY

According to Snyder (2019), there are three approaches to conducting a literature review, namely; systematic, semi-systematic and integrative. All these approaches are achieved through the following phases, 1) purpose, 2) research questions, 3) samples characteristics, 4) analysis and 5) contribution. In order to achieve the objectives of this study, a PRISMA review of literature was performed. The purpose of the study is to develop a framework that guides the human capital of the logistics industry to achieving a successful implementation and management of Logistics 4.0 practices. The research questions are previously mentioned in the first section of this study (i.e., introduction). The samples used as sources of information are journal papers found using the search engine "google scholar", using the following key words; human capital development, Logistics skills and supply chain management skills, these keywords were linked with other keywords, namely; Industry 4.0 and Logistics 4.0. The analysis phase will be of a qualitative nature, through thorough classification of the samples collected in terms of relevance, then this information is analyzed in terms of contribution to achieving the objectives of this study and answering the research questions. Finally, the contribution of this study is the providence of a theoretical framework that help the logistics human capital to successfully administer and manage Logistics 4.0 practices in order to fill the gap between current nascent logistics practices and globally renowned practices, i.e., Logistics 4.0.

The reasons of using the search engine "Google Scholar" in this study are as follows:

1. Google scholar search engine is an integrated academic database which covers all academic and industry papers, magazines, company reports, and so on. The two most reliable databases called Scopus and Web of Science (WoS) are not indexed all journals in both databases simultaneously. As a result, it creates conflict of information which limited number of journal publications can be retrieved.
2. Although Google Scholar covers most of the academic efforts, other publications such as magazines, reports and company newsletters are also significant since the human capital development in logistics and supply chains are mostly circulated via this channel.
3. The findings of the review resulted from the following steps that were taken in sequence; defining the criteria for satisfying the review questions, dividing these review criteria into sets of keywords, using "Google Scholar" to track the peer-reviewed articles that satisfied the review criteria, and performing the PRISMA steps to include the findings that answered the review questions.

PRISMA systematic literature review

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was utilized as the review method. The scheme was devised by 29 scientists, researchers and reviewers back in 2005 as a 27-item checklist to accomplish an evidence-based transparent reporting of systematic literature reviews (Liberati et al., 2009). The review process is also described in the form of a flowchart. The first field is known as the identification step. It identifies the total number of resources with the extraction of duplicates. The second field is known as the screening step. In this step, the outcome of the first step is screened to determine which resources match the review criteria, with the exclusion of the remaining resources. The third field is known as the eligibility step, and it investigates the outcome of the second field to determine which resources satisfy certain criteria and which resources do not. Lastly, the fourth field mentions the number of resources included in the findings of the review (Moher et al., 2009).

PRISMA offers a great opportunity to confront emerging topics and provides a replicable research procedure that walks the reader through the entire review process (Lagorio et al., 2016). Hence, this method was chosen because it can deliver the answers to the review questions by drawing a continuous literature path that can provide an understanding of current and globally-renowned terms and industrial trends. Moreover, this method offered the means to determine the human capital of the logistics industry to achieving a successful implementation and management of Logistics 4.0 practices. Further explanation about this PRISMA systematic literature review is well explained by Kon, Abdul Rahman, Md Hanafiah & Abdul Hamid (2021).

5. SYNERGY OF INDUSTRY 4.0 AND HUMAN DEVELOPMENT SKILLS IN LOGISTICS

This study suggests a comprehensive human capital development in logistics framework that deals with the four essential components of the logistics industry, i.e., Operatives, Supervisors, Managers and Government. The first component of the framework deals with the operatives' level of the logistics hierarchy by utilizing what is known as the operative workstation interaction framework (OWI), the second with the supervisors' level, the third with the managers' level and the fourth with the government (see Figure 2).

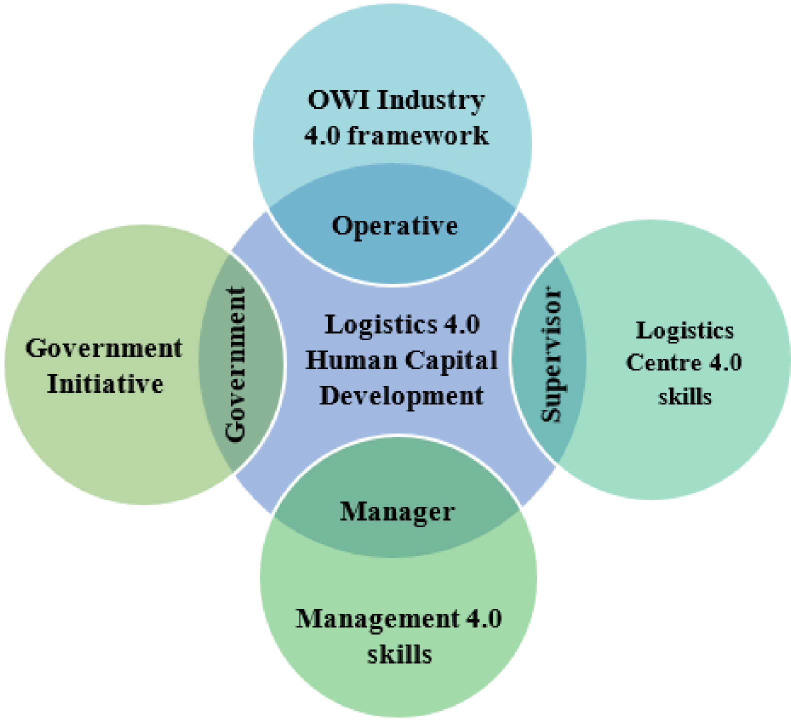

Figure 2. Logistics 4.0 human capital development framework

5.1 Operative level

For the "operatives" level, the "Operative Workstation Interaction (OWI) framework" suggested by (Golan et al., 2020) was found to be applicable. This framework is schemed for an Industry 4.0 work environment. This framework regulates the operations and status of the operatives and the workstation, and it is comprised of three components, namely; Observation, Analysis and Reaction. As shown in Figure 3, the operator and workstation influence and give input to one another, the observation component receives input from the operative, the workstation and the reaction component, the analysis component receives input from the observation component and gives input to the reaction component.

The input from the operator and workstation is divided into, operator or workstation input, momentary profile and profile trajectory. The operator or workstation input are specific data, such as; operator heartrate and blood pressure or workstation temperature and light, and they are gathered from sensors. The momentary profile summarizes the measures provided by the operator or workstation input every few seconds with an algorithm that regulates the optimum display time of these measures. The profile trajectory collects the data of several momentary profiles to determine the change in the operator or the workstation status.

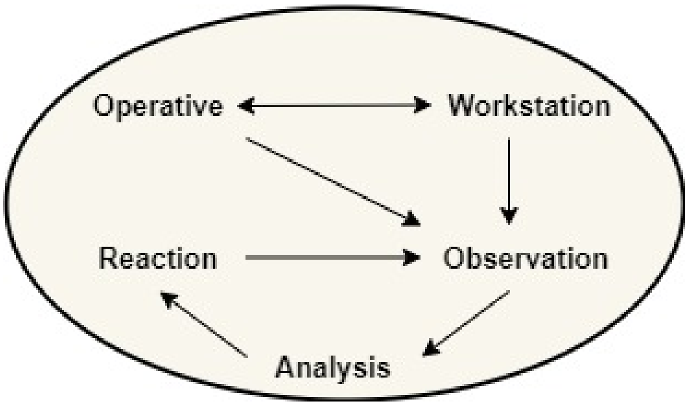

Figure 3. Schematic of the OWI theoretical framework

The analysis component is comprised of four elements, namely; the state of the operator and the workstation, error analytics and planning. From the observation input that describes the operator and workstation states, the analysis component identifies the physical and mental state of the operator and the overall efficiency of the workstation. After that, the analysis of error is conveyed in three steps, prevent, monitor and correct. Firstly, preventing an error is achieved by analysing the observation input and determine the likelihood of errors arising. Secondly, monitoring the change in the states of the operatives and the workstation by assessing the system and evaluate the appropriate strategy for change if needed. Thirdly, is error detection and correction by any means, e.g., governing operatives or workstation. In the final element of the analysis component, i.e., planning, the optimum strategy is selected and transmitted to the reaction component as input.

During the reaction component the input from the analysis component is broken-down into a reaction input that has three properties, namely; perceptual, timing and strength. The perceptual properties define the media through which the reaction is delivered to the designated employees, e.g., sound, video or perceptible message. Examples of the timing properties are; frequency, length and send-time of the reaction massage. Lastly, the strength of the message determines its importance, sensitivity and the magnitude of its effect.

The OWI framework aims at optimizing the operative workstation dynamic to achieve an agile and an autonomous work environment. It represents the perfect addition to an establishment that is already governed by Industry 4.0 practices, hence, what this framework lacks are defining the adopted Information Technology (IT) solutions and technologies to make this framework operational in day to day practices.

5.2 Supervisor level

The supervisors' level might be the most crucial level in terms of successfully maintaining Industry 4.0 standard practices. Following the assumption that the responsibility of organizing and managing the operational aspects of logistics fall in the hands of supervisors, the authors of this work adopted the concept known as "Logistics centre 4.0" which defines and classifies the supervisor activities that should disturb the logistics operations and transition it to Industry 4.0 standards. "The logistics centre 4.0" concept was introduced by (Yavas & Ozkan-Ozen, 2020) (see Figure 4). It states that achieving a logistics 4.0 establishment require management in four major logistical areas, i.e., information, transportation, handling and warehouse. Hence, the argument the authors are marking is that a logistics supervisor must be skilled in these four logistical areas.

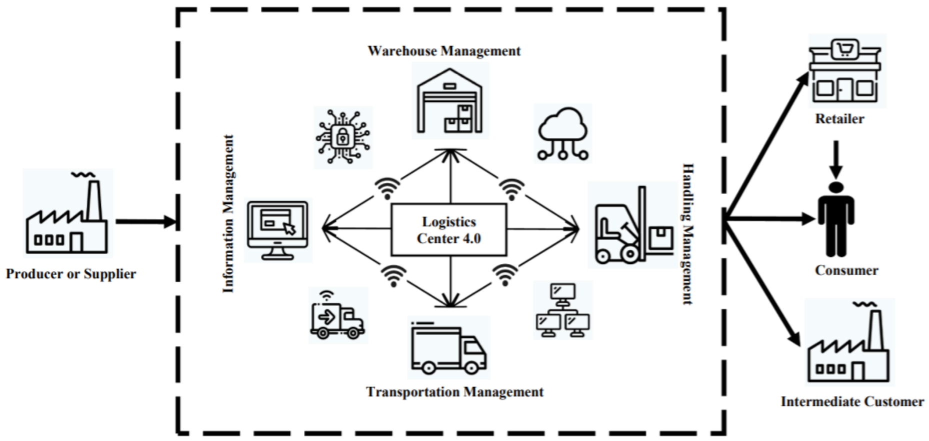

Figure 4. Logistics centre 4.0 framework (Yavas & Ozkan-Ozen, 2020)

A logistics supervisor must guarantee the sharing of information and connectivity when it comes to processing orders, controlling inventory, producing entities and performing warehouse and accounting duties. Also, they must be equipped in managing transportation by selecting the right mode of transportation and thoroughly mange the company's fleet of vehicles. Moreover, they must be in control of moving, storing, and disposing cargo. Lastly, they must be skilled in the four main elements of warehouse management, which are; receiving, storing, picking and shipment of orders.

The logistics centre 4.0 framework is very comprehensive and if successfully applied it can achieve cost-effective and dynamic logistical operations. But this framework falls short to meet the autonomy condition of Industry 4.0. This is evident in the fact that the framework states that information sharing is a function of the logistics supervisor rather than the logistics supervisor practices being a function of information sharing, as in the use of big data and internet of things controlling and optimizing the functions of the logistics supervisor, which consequently will lead to autonomous and swift operations.

5.3 Manager level

For the managers' level, the Business Logistics Management (BLM) framework was employed for the suggested framework. The BLM framework suggests that supply chain managers should have the right skills in three main fields: Business, Logistics and Management. This framework was first suggested by Poist, (1984) and it was adopted as the substratum of the optimum skills a manger of logistics 4.0 operations should have. Since this framework was schemed before Industry 4.0, this study has proposed a new framework called; Industry 4.0 BLM theoretical framework. Figure 5 depicts the suggested Industry 4.0 BLM framework. The BLM framework has already revolutionised the functions of the logistics managers since its introduction back in the 1980s, but the disruption of Industry 4.0 came in almost 30 years later. Hence, it is crucial to redesign the BLM framework to satisfy the requirements of Industry 4.0. The suggested BLM framework that is designed by the authors added specific skills that relate to Logistics 4.0 managerial practices in order to adjust the BLM framework to suit the Industry 4.0 requirements.

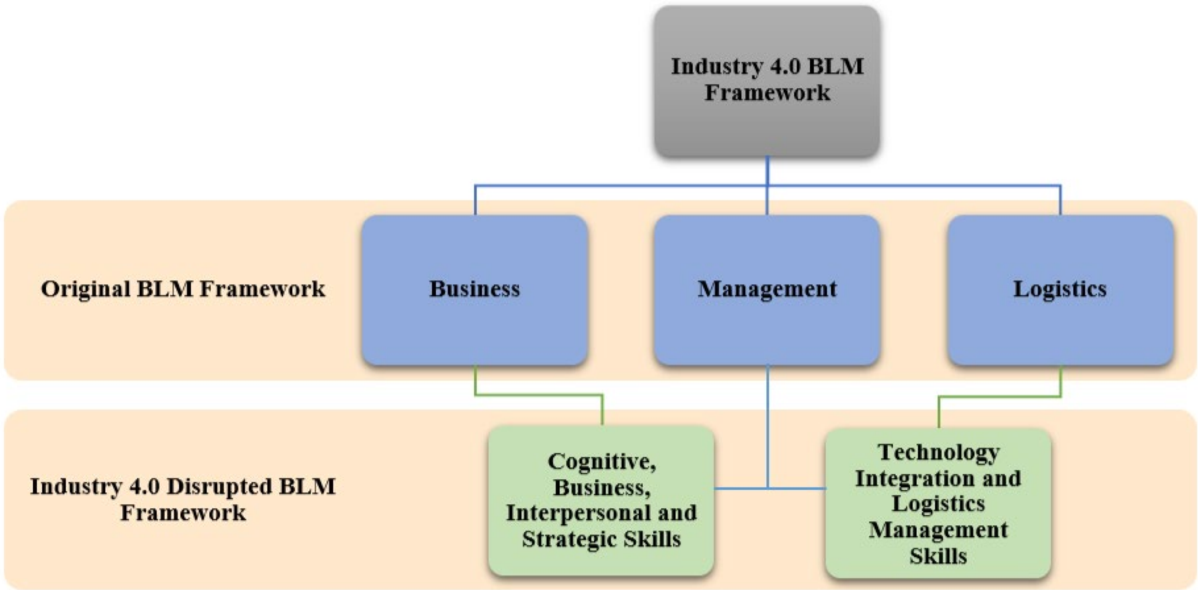

Figure 5. Industry 4.0 BLM theoretical framework.

Guzmán et al., (2020) argued that managers in the Industry 4.0 era should have four sets of skills, namely; cognitive, business, interpersonal and strategic. These sets of skills were obtained from a model suggested by Mumford et al., (2007). These skills were adopted by the authors of this work for the sub-level of the Management and Business skills of the suggested Industry 4.0 BLM framework (see Table 1).

Table 1. Management and business skills for Industry 4.0 managers (Guzmán et al., 2020)

Cognitive Skills	**Business Skills**	**Interpersonal Skills**	**Strategic Skills**
Speaking, listening, writing, reading comprehension, learning and critical thinking	operations analysis, management of personnel resources, management of financial resources and management of material resources	social perceptiveness, coordination, negotiation and persuasion	Visioning, systems perception and evaluation, identification of downstream consequences, identification of key causes, problem identification and solution appraisal

Pinzone et al., (2017) suggested that managers in the Industry 4.0 era should possess certain skills in several major areas of the industrial practices. The authors of this study found that three of these areas were suited for the Management and Logistics sub-level of the Industry 4.0 BLM framework, namely; Technology integration, Supply chain and Operations (see Table 2).

Table 2. Management and logistics skills in the Industry 4.0 era (Pinzone et al., 2017)

Technology integration
• Developing technology implementation strategies. • Selecting suitable CPS tools (e.g. mobile application interface and AR). • Implementing IT networks for autonomous operations. • Applying and selecting communication procedures using (IoT, Big data and the cloud). • Using simulation tools for simulating “what if scenarios”. • Using graphic modeling tools for designing software and hardware components.

• Developing strategies for cybersecurity and data privacy.
Supply chain
• Development and management of digital supply networks. • Utilizing virtual design for business practices. • Market prediction using Big data analytics. • Developing IT protocols for collaborative platforms creation using IoT and the cloud. • Autonomous and swift technologies for management, leveraging and monitoring
Operations
• Ongoing strategizing in adopting Industry 4.0 technologies. • Modeling, analyzing and simulating production using Big data analytics. • Utilizing smart products and devices, e.g., smart phones and tablets, for production control. • Utilization of collaborative robotics. • Usage of additive manufacturing solutions. • Human resources management using interconnected devices and technologies. • Developing predictive maintenance strategies and solutions using data flow analytics. • Designing maintenance monitoring protocols. • Remote monitoring of operations using AR and simulation tools.

5.4 Government initiative

The government plays a crucial role in paving the way towards an Industry 4.0 standardized logistics practices. And the reason for that is the labour force distribution and planning being an essential function of the government. McKinnon et al., (2017) argued that the government support of the logistics capital development can come in two forms, i.e., regulations and direct support (see Table 3). In terms of regulations the government can develop several strategies, like facilitating the collaborations between the local logistics entities and major players in the market. Additionally, developing governing policies aiming at enhancing the skills of the logistics capital. For example, enforcing on local logistics institution a certain number of training hours for their fresh employees and policies aiming at optimizing the education of students through curriculum development. Moreover, raising awareness on the importance of training programs and skills development.

Table 3. Government initiative to optimizing logistics practices (McKinnon et al., 2017)

Regulations	Direct support
• Collaborations between logistics institutions. • Global standards (e.g., CILT, CSCNP and BLV). • Governing policies (e.g., mandatory training hours). • Education policies and curriculum development. • Raising awareness.	• Financial support for training programs. • Improving employees' skills in government-owned logistics institutions. • Gaining leverage on private-owned logistics companies. • Adding human capital investment to infrastructure development strategies. • Spatial planning depending on labor availability.

The government can provide financial support directly and indirectly to help optimize the local logistics practices. In the direct sense the government can fun training programs and manage them or outsource them to private specialized institutions. Indirectly the government can offer financial support to logistics companies that satisfy certain eligibility criteria, and this financial support can be per allowance for each employee getting trained or can be in the forms of tax rebates or block grants. Consequently, the government must insure proper expenditure of their support. the government can lead the logistics companies by setting a good example of proper human capital development activities in their own logistics businesses. It can also sell their businesses to only those who satisfy the eligibility criteria that relate to the capital skill. In addition, the government should add investing in human capital to its infrastructure development agenda. Lastly, the government's spatial planning should highly depend on the availability of skilled labour.

6. DISCUSSION AND CONCLUSION

History has showed that the human capital is at the heart of all previous industrial revolutions, and for Industry 4.0, the role of the human capital is very much essential, without capable employees the practices of Industry 4.0 will never be applied. Hence, it goes without saying that in order to draw a path for adopting Industry 4.0 practices nationwide, the driver of that path must be the human capital. The logistics industry nowadays is governed through operational activities that are a result of harmonious interaction between man and technology.

These technologies even though they are schemed by humans, they are self-performing and self-optimizing. This in a different sense diminishes the role of the human capital, and that is evident in the self-driving robots and vehicles that outperforms the human worker in many aspects such as; strength, speed and operating continuously. And even though Industry 4.0 can replace many low-level and low skills demanding jobs, it also acts as a motivator to produce more skilled labour. That is the reason why countries around the world thrive to enhance their education and training programs in order to keep up with the modern technology and modern demands of the market especially in the logistics sector. Moreover, the international logistics community is known to rank logistical performances of the countries. And these ranks are conveyed in world renowned indices that affect the reputation of the logistical performances of the country. An example of such is the Logistics Performance Index (LPI) that measures the country's logistical performance by evaluating the industry's professionals and their activities domestically and internationally. This gives more reason to better invest in the logistics human capital in order to keep up with an ever-developing world.

It has been proven that defining the influential human capital in the logistics sector is a critical matter in order to design a comprehensive framework that satisfies the main objective of this study, which is a guide towards successful implementation and management of Industry 4.0 practices in the logistics sector (i.e., Logistics 4.0). Poist (1984) suggested the BLM framework as a guide towards developing the managers of the logistics sectors to acquiring skills necessary for the development of the logistics sector. It proved to be useful when tackling issues concerning the development of managers as a mean towards developing logistics organizations, but for the current needs of the logistics sector the suggested human capital development (HCD) framework is capable of pushing the logistics sector towards an up-to-date state (see Table 4).

Table 4. Comparison between the BLM framework and the HCD framework

Comparison elements	**BLM framework**	**Human capital development (HCD) framework**
Targeted elements of the logistics Industry	The BLM framework only targets employees at the management level	The HCD framework targets employees at all levels that are influential to the logistics operation (management,

		supervision, operation, and government)
Generality	The BLM framework is oriented towards developing the employees to achieve local goals, within the scope of an organization	The HCD framework aims at developing the human capital within an organization and the government as well, which makes it applicable to the national level
Practicality	The BLM framework focuses on developing skills of management in order to enhance organizational operations.	The HCD framework focuses on the hierarchal levels of the logistics industry and providing suitable guidance for each level, i.e., not necessarily a guide to skills development, e.g., for the supervision level the HCD provides a guide to Logistics 4.0 operational aspects.
Significance	The BLM framework is obsolete to a certain extent, it serves best as a foundation for more currently relevant theoretical models and framework	The HCD framework aims at achieving Industry 4.0 practices in the logistics sector, by guiding the human capital into utilizing up-to-date technologies and practices.

The human capital development framework can be considered to be advantageous in terms of satisfying organizational and national goals. Focusing on the fact that it deals with the hierarchical levels of the industry along with the government's role, it shows that it can be of a great benefit in terms of raising awareness to the importance of Industry 4.0 mindset and the technologies it has brought forth. Moreover, it's greatest worth is acting as a steppingstone for policy makers in the country to govern the awareness of local logistics businesses in order to raise the stature of the country's logistical practices. The suggested subframes for the logistics hierarchal levels suit the needs of each level for it to reach its optimum status. The OWI framework provides theoretical modeling for optimizing the performance of operatives not just in a logistics institution but also in any other operational industry. The logistics centre 4.0 concept and the skills for management in Industry 4.0 era, generalize the details required for managing a sophisticated logistics institution that can have a competitive value. These advantages all help build the biggest advantage, which is elevating the logistical stature of a whole nation through creating great values and ultimately achieving economy and market enrichment.

Industry 4.0 disruption is globally eminent, and the logistics industry represent the perfect environment for its growth (Wang, et al., 2020). Industry 4.0 can be summarized into three terms (digitization, autonomy, and data), it is the amalgamation of four major elements, i.e., IoT, Big data, CPS and smart factory. When Industry 4.0 technologies (e.g., AI, AR, Cloud computing, Blockchain, etc…) are utilized in logistics practices, it creates a Logistics 4.0 environment (Wang, et al., 2021). And the key to successfully implementing Logistics 4.0 practices is the human capital of the logistics industry. The human capital of the logistics industry was found to be classified into four major categories, namely; operatives, supervisors, management and government.

The study answered the research questions below,

Q1: How can we fill the gap between the current logistics practices and Industry 4.0 practices?

- A1: We offer by conducting a new human capital development (HCD) framework to fill the gap between the current logistics practices and Industry 4.0 practices.

Q2: What makes the human capital development a key enabler to shrink or illuminate the gap between the current logistics practices and Industry 4.0 practices?

- A2: Section 5. Synergy of industry 4.0 and human development skills in logistics explains it in a detailed manner based on operative, supervisor, manager levels and government initiative. Then, Table 4. Comparison between the BLM framework and the HCD framework compares the proposed method in terms of generality, practicality and significance.

This search highlighted the studies that proved to be useful in terms of optimizing each major category of the logistics capital. The novelty of this study is represented in the creation of a theoretical framework that directs the logistics capital towards a successful implementation and management of Logistics 4.0 practices. Human is an important element of logistics and supply chain operations (Wang et al., 2022). The purpose of this research is to provide a theoretical framework to assist logistics human capital in effectively administering and managing Logistics 4.0 practices to bridge the gap between present fledgling logistics practices and globally recognized practices, i.e., Logistics 4.0. In addition, this research has added to the body of information in the literature, which may be expanded in numerous ways of research and practice in the future. The limitation of this research is from the PRISMA systematic literature review. There is no involvement of both academic and industry experts at the current study. Therefore, suggestion of future study is to analyse the proposed a new human capital development (HCD) framework using an empirical method incorporating the expert's involvement directly.

ACKNOWLEDGEMENTS

The authors would like to thank both The Research Centre (TRC), Ministry of Higher Education and International Maritime College Oman, Sultanate of Oman for providing the research funding for this project through the grant numbers RE01 and CRG07. Also, we would like to thank Mr. Abubaker Omer, Research Assistant for assisting us in completing this research project.

DECLARATION OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Abudaqa, A., Hilmi, M. F., Dahalan, N., & Almujaini, H. (2020). Impact of supply chain integration and intelligent information systems in achieving supply chain innovation: A study of retail trading SMEs in Abu Dhabi, UAE, *Uncertain Supply Chain Management*, *8*(4), 721-728.

Barleta, E., Pérez, G., & Sánchez, R. (2019). La revolución industrial 4.0 y el advenimiento de una logística 4.0. *Boletín FAL*, *7*.

Barreto, L., Amaral, A., & Pereira, T. (2017). Industry 4.0 implications in logistics: An overview. *Procedia Manufacturing*, *13*, 1245-1252.

Bhattacharyya, S. S., & Mandke, P. (2021). Exploratory Study of the Role of Emerging Technologies in Outsourcing of Supply Chain Functions. *International Journal of Applied Logistics* , 11(2), 71-98.

Buhr, D. (2015). *Social innovation policy for Industry 4.0*. *Friedrich Ebert Stiftung*. Retrived from https://www.researchgate.net/publication/330970346_Social_Innovation_Policy_for_Industry_40 [Accesesed: 16 July 2021].

Bvepfepfe, B. S., Suri, A. K., & El Asad, A. (2019). Adoption of emerging technologies in supply chain operations for cost reduction and enhancement of shareholder wealth: A case study of UAE organization. In: Barolli L., Xhafa F., Khan Z., Odhabi H. (eds) Advances in Internet, Data and Web Technologies. EIDWT 2019. *Lecture Notes on Data Engineering and Communications Technologies*, *29*, Springer, Cham.

De Pleijt, A., Nuvolari, A., & Weisdorf, J. (2020). Human capital formation during the first industrial revolution: Evidence from the use of steam engines. *Journal of the European Economic Association*, *18*(2), 829–889.

Elgendy, A. F. (2021). The mediating effect of big data analysis on the process orientation and information system software to improve supply chain process in Saudi Arabian industrial organizations. *International Journal of Data and Network Science*, *5*, 135–142.

Ellinger, A., Shin, H., Northington, W. M., Adams, F. G., Hofman, D., & O'Marah, K. (2012). The influence of supply chain management competency on customer satisfaction and shareholder value. *Supply Chain Management*, *17*(3), 249-262.

Flores, E., Xu, X., & Lu, Y. (2020). Human capital 4.0: A workforce competence typology for Industry 4.0. *Journal of Manufacturing Technology Management*, *31*(4), 687-703.

Francisco, K., & Swanson, D. (2018). The supply chain has no clothes: Technology adoption of blockchain for supply chain transparency. *Logistics*, *2*(1), 1-13.

Galli, B. J. (2021). Relationship Between Cost of Poor Quality and Continuous Improvement: Reflection of Literature. *International Journal of Applied Logistics*, 11(2), 55-70.

Gillies, D. (2017). Human capital theory in education. In *Encyclopedia of Educational Philosophy and Theory*. Springer, Singapore.

Goffee, R., & Scase, R. (2015). *Corporate realities (Routledge Revivals): The dynamics of large and small organisations* (1st ed.). Routledge, London.

Golan, M., Cohen, Y., & Singer, G. (2020). A framework for operator– workstation interaction in Industry 4.0. *International Journal of Production Research*, *58*(8), 2421-2432.

Gruzina, Y., Firsova, I., & Strielkowski, W. (2021). Dynamics of human capital development in economic development cycles. *Economies*, *9*(2), 1-18.

Gumzej, R. (2022). Safety and Security Beyond Industry 4.0. *International Journal of Applied Logistics*, 12(1), 1-10.

Guzmán, V. E., Muschard, B., Gerolamo, M., Kohl, H., & Rozenfeld, H. (2020). Characteristics and skills of leadership in the context of Industry 4.0. In *Procedia Manufacturing*, *43*, 543-550.

Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, *89*, 23-34.

Hozdić, E. (2015). Smart factory for industry 4.0: A review. *International Journal of Modern Manufacturing Technologies*, *7*, 28-35.

Hult, G. T. M., Ketchen, D. J., Cavusgil, S. T., & Calantone, R. J. (2006). Knowledge as a strategic resource in supply chains. *Journal of Operations Management*, *24*(5), 458-475.

Khan, M. (2019). Challenges with big data analytics in service supply chains in the UAE. *Management Decision*, *57*(8), 2124-2147.

Maré, D. C. (2006). What do Endogenous Growth Models Contribute? Motu Working Paper No 2004-04. *SSRN Electronic Journal*, 1-30.

Matousek, R., & Tzeremes, N. G. (2021). The asymmetric impact of human capital on economic growth. *Empirical Economics*, *60*(3), 1309–1334.

McKinnon, A., Flöthmann, C., Hoberg, K., & Busch, C. (2017). *Logistics competencies, skills, and training: A global overview*. World Bank Studies. Washington, DC: World Bank. *Retrieved from https://openknowledge.worldbank.org/handle/10986/27723* [Accessed: 16 July 2021]

Mokyr, J. (2018). The past and the future of innovation: Some lessons from economic history. *Explorations in Economic History*, *69*, 13-26.

Mumford, T. V., Campion, M. A., & Morgeson, F. P. (2007). The leadership skills strataplex: Leadership skill requirements across organizational levels. *Leadership Quarterly*, *18 (2),* 154-166.

Pinzone M., Fantini P., Perini S., Garavaglia S., Taisch M., & Miragliotta G. (2017). *Jobs and skills in Industry 4.0: An exploratory research*. In: Lödding H., Riedel R., Thoben KD., von Cieminski G., & Kiritsis D. (eds), Advances in Production Management Systems. The Path to Intelligent, Collaborative and Sustainable Manufacturing. APMS 2017. IFIP Advances in Information and Communication Technology, vol 513. Springer, Cham., 282-288.

Poist, R. F. (1984). Managing logistics in an era of change. *Defense Transportation Journal*, *40*(5), 22–30.

Qin, J., Liu, Y., & Grosvenor, R. (2016). A Categorical Framework of Manufacturing for Industry 4.0 and beyond. In *Procedia CIRP*, *52*, 173-178.

Schultz, T. W. (1993). The Economic Importance of Human Capital in Modernization. *Education Economics*, *1*(1), 13-19.

Seebacher S., Schüritz R. (2017). Blockchain technology as an enabler of service systems: A structured literature review. In: Za S., Drăgoicea M., Cavallari M. (eds) Exploring Services Science. IESS 2017. Lecture Notes in Business Information Processing, vol 279. Springer, Cham., 12-23.

Shafiq, S. I., Szczerbicki, E., & Sanin, C. (2019). Proposition of the methodology for data acquisition, analysis and visualization in support of Industry 4.0. *Procedia Computer Science*, *159*, 1976-1985.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333-339.

Taderera, F., Mubarak Al Qasmi, M. M., & Al Balushi, M. S. (2018). Analysing Oman Supply chain practices versus global best practices. *Global Journal of Business Disciplines*, *2*(1), 86-105.

Tijan, E., Aksentijević, S., Ivanić, K., & Jardas, M. (2019). Blockchain technology implementation in logistics. *Sustainability, 11*(4), 1-13.

Umachandran, K., Jurčić, I., Corte, V. Della, & Ferdinand-James, D. S. (2019). *Industry 4.0:*

The New Industrial Revolution. In: Dey, N., & Tamane, S. (eds), Big Data Analytics for Smart and Connected Cities, IGI Global, Pennsylvania, USA, 138-156.

Wang, M., Asian, S., Wood, L.C. and Wang, B. (2020), "Logistics innovation capability and its impacts on the supply chain risks in the Industry 4.0 era", *Modern Supply Chain Research and Applications*, Vol. 2 No. 2, pp. 83-98.

Wang, M., Wood, L. C., & Wang, B. (2022). Transportation capacity shortage influence on logistics performance: evidence from the driver shortage. *Heliyon*, 8(5), e09423

Wang, M., Wu, Y., Chen, B., Evans, M. (2021) Blockchain and Business Supply Chain: A New Paradigm for Business Supply Chain Collaboration and Integration beyond Cryptocurrency, Payment, and Finance, *Operations and Supply Chain Management: An International Journal*, Vol. 14 No. 1, 111-122

Wuttaphan, N. (2020). Human capital theory : The theory of human resource development, implications, and future. *Rajabhat J. Sci. Humanit. Soc. Sci.*, *18*(2), 240–253.

Yavas, V., & Ozkan-Ozen, Y. D. (2020). Logistics centers in the new industrial era: A proposed framework for logistics center 4.0. *Transportation Research Part E: Logistics and Transportation Review*, *135*, 101864.

Yousif Alsharidah, Y. M., & Alazzawi, A. (2020). Artificial intelligence and digital transformation in supply chain management a case study in Saudi companies. In *2020 International Conference on Data Analytics for Business and Industry: Way Towards a Sustainable Economy (ICDABI)*, 1-6.