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Public services for business environment: challenges for implementing Industry 4.0 in Polish and Canadian logistic enterprises

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Abstract: *This study examined the relationship between Industry 4.0 technologies and logistic enterprises' performance through interlinked mediating predictors creating challenges for effective and efficient implementation of Industry 4.0 concepts in order to examine how the public services for business environment could be effectively employed. For the purpose of fair and equal representation, we combined purposive, referral, convenience, and area-cluster sampling strategies to reach total 320 (160 each) logistic enterprises in Poland and Canada. Using SPSS 23.0, we employed multiple regression test to examine the impact of various interlinked predictors affecting the performance of logistic enterprises. Results revealed that related to Industry 4.0 "limited knowledge", "implementation barriers", "recognition of potential changes", "benefit appearance time period", "preparing staff for challenges", and "other priorities than introduction of Industry 4.0" statistically significantly mediate the relationship between Industry 4.0 technologies and performance of logistic enterprises in Canada and Poland. The comparative analysis revealed that apart from 'preparing staff for challenges', all other predictors are higher in Canada than Poland. The findings also revealed that the Industry 4.0 technologies have statistically significant impact on the Polish and Canadian logistic enterprises' performance. Based on the findings and role of public services for business environment, recommendations are given to logistic companies for effective and efficient implementation of Industry 4.0 concepts.*

Keywords: *public services for business environment, Industry 4.0 technologies, Industry 4.0 challenges, enterprises' performance, comparative study*

JEL: L26, O31, O33.

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Introduction

It has become essentially important to measure the economic and social impact of the policies and procedures implemented by the public sector on the societies (Ramrayka, 2012). Public services are not just limited to the public sector but has its impact on private enterprises equally because individuals working in any sector are part of the society, so no one is excluded from the impact of general and/or specific policy. Continuing in same vein, it is argued that, "the public services for the business environment is not specifically limited to the public sector as the significant demonstration effect of the role of governmental administration is evident in the advanced economies for the efficient delivery of services, provision of information and internal efficiency of the public administration" (Dănăiață, Margea, Hurbean, and Artene, 2014; p. 351). The major purpose of governmental reforms in the recent times in the middle-ranged economy has agenda for the reduction of corruption, enhancement of transparency, and quality of service so that the implementation benefits the public and private enterprises (Dănăiață et al., 2014; Androniceanu, 2019a). One of the important aspects in this regard is to explore the attitude of the enterprises towards the communication and information technologies and the public administration relationship with the enterprises to improve the business environment for not public but private enterprises through its services.

For nearly a decade, both enterprises and their clients have been preparing to function in the new reality set by the fourth industrial revolution, which is often referred as "Industry 4.0". Currently, industry is undergoing transformation and evolution towards the full digitization and intelligence of a production processes to ensure high efficiency and it is necessary to implement new technologies for the automation of industrial processes to achieve it (Petrillo et al., 2018; Androniceanu, 2019b). The new industry organization model is based on specialized manufacturing, horizontal integration within cooperating networks and digital integration of the supply chain (Brettel et al., 2014). Although technological advances themselves do not have to be at the root of a groundbreaking change (Drath and Horch, 2014). Their impact on the product conception, manufacturing and distribution, and in particular on the way companies create, separate and accumulate, is highly invaluable. Also important are changes in inter-institutional relations within the organization of work as well as in the society.

In recent years, the field of logistics has changed significantly due to the large number of technological innovations based on cyber-physical systems (CPS) that allow two-way information flow between executive and decision systems (Timm and Lorig, 2015). Technologies specific to Industry 4.0 (e.g. Big Data Analytics, Cloud Services, 3D-Printing, Cyber Security, Autonomous Robots, Internet of Things, Augmented Reality) supporting physical logistics processes increase computational and communication capabilities. The reason behind it is that all resources and relevant product components are able to communicate with each other to exchange necessary information. There has also been a transition from traditional supply chains to an open supply network. Aspects such as flexibility, adaptability, proactively and self-

organization are gaining in importance and can only be achieved through the integration of new smart technologies.

Industry 4.0 definitely has the strongest impact on the production environment by modifying traditional and optimizing relatively new production operations. However, it also strongly affects the operations of logistics companies as it enables real-time interaction and dynamic self-optimization of flow processes. The fourth industrial revolution brings computerization of logistics processes and significantly changes the way the industry works. The new concept emphasizes the dispersion of activities and the independence of their management, as well as the intelligent connection of logistics infrastructure via the network. Yet, there is still under research area to investigate the different variables mediating the impact of Industry 4.0 on the performance of enterprises.

However, despite its ability to attract the number of researchers, there is still under research area to examine the variables of interest in comparative mode. In other words, there is no conclusive evidence regarding the knowledge and implementation of Industry 4.0 concepts in two differing economies. There are some efforts made by researchers to investigate the determinants of Industry 4.0 in China (Imran et al., 2018) and the concepts of Industry 4.0 in the textile and cargo logistic sector of Pakistan (Imran, Waseem and Haque, 2018). Nevertheless, both these studies are from the Asian region, reflecting the specific region to understand the concepts of Industry 4.0. There is still no conclusive evidence from the Eastern European country in comparison with the Northern American region for the comparison. Since, one region (Eastern Europe) is more in the middle ranged/emerging economy) while the other blog is developed economy (North America). Therefore, it is an interesting attempt to go one step beyond less developing or improving emerging economies to compare the middle-ranged and developed economies. Since, the Canada-Poland has a strategic ties and both are the members of NATO, working in collaboration for the "Economic Co-operation and Development, and the International Holocaust Remembrance Alliance, as well as in a wide range of United Nations organizations and initiatives" (Government of Canada (GoC), 2018), thus the two countries share strong personal ties. Furthermore, "Poland is Canada's largest goods trading partner in central and eastern Europe. The Canada-European Union Comprehensive Economic and Trade Agreement provide opportunities to further strengthen the bilateral economic relationship" (GoC, 2018). There is also a youth mobility agreement between two countries to travel and work in each other's country for up to one year (GoC, 2018), therefore, this reflects that there are high economic strategic ties. As a result, of these strategic ties, the agreements to exchange information and technologies in different sectors, especially in the Cargo Logistics is relatively higher, hence, it would be interesting to compare these two countries to further expand of cultural-context by delimiting the region-specificity.

Therefore, the purpose of this article is to verify the knowledge and implementation of the Industry 4.0 concept in Polish and Canadian companies in the logistics industry. Almada-Lobo (2016) found that Industry 4.0 plays vital role in the manufacturing sector. However, there is no conclusive evidence from service sector.

In addition to that, there is no conclusive evidence from comparative lens regarding the role of public services for business environment to facilitate the enterprises in improving their attitude towards communication and information technologies.

1. Literature review

The popularization of the idea of Industry 4.0 prompted many researchers to try to define it. Kagermann et al. (2013) believe that Industry 4.0 is a "network of autonomous production resources, capable of controlling itself in response to various situations, self-configuring, knowledge-based, equipped with sensors and spatially dispersed, as well as including appropriate planning and management systems". According to Lasi et al. (2014) ""Industry 4.0 describes the growing digitization and automation of the production environment, as well as the creation of digital value chains to enable communication between products, the environment and business partners." Hermann et al. (2016) define Industry 4.0 as a "collective definition of technology and concept of organization of the value chain." Oesterreich and Teuteberg (2016) stated that from a technical point of view this new industrial paradigm can be described as increased digitization and automation in the production environment, in addition to increased communication through the creation of digital on the value chain. The limited knowledge regarding the operations and concepts of the industry 4.0 creates the challenges for the organisations to perform and compete adequately (ATCC Finance, 2015). Although, however, the digital transformation enhances due to industry 4.0 but the limited knowledge in the sector creates a challenge for better performance (ATCC Finance, 2015). The future of production, but also logistics, as predicted by Industry 4.0, will rely on ubiquitous integration, where all elements of the production exchange information, launch operations and independently control themselves (Weyer et al., 2015, Mura et al., 2017; Ohanyan, Androniceanu, 2017). Anyway, in this sense Industry 4.0 is defined by Stock and Seliger (2016), putting the concept as: "horizontal integration of products, various stakeholders, such as customers, employees or suppliers, as well as production devices that are embedded in a virtual network and exchange data between different phases of the product life cycle." This approach, which aims to create smarter processes, is characterized by decentralized and digitized production networks that operate without human intervention and independently control their activities depending on changes and environmental requirements (Erol, et al., 2016; Vasile, Androniceanu, 2018).Thanks to an open, active, dynamic and flexible communication system equipped with information technologies, Industry 4.0 creates a new logistics model that has the ability to maximize optimization potential, increase flow speed and encourage the use of innovative solutions. (Li et al., 2017).

Li, Fast-Beglund and Paulin (2019) investigated the current and future Industry 4.0 capabilities for information and knowledge sharing in the Swedish SMEs. Their findings revealed that understanding the changes are essential for the companies to succeed. The challenges of complexities are created by the uncertainties and changes, while sharing information and knowledge enables these companies to manage such challenges in relation to implementation of Industry 4.0 concepts so that

the competitive advantage is attained through improved performance (Li et al. 2019). Nagy et al (2018) found that various implementation barriers hindering the performance of the companies. Nevertheless, Stentoft et al. (2019) argued that the drivers and barriers for the Industry 4.0 including transformation and implementation barriers reduce the chances of the SMEs to be ready for the digitalized process.

Another important challenge for the organisations is to prepare the staff according to the situation. Training and improving the skills, knowledge, capabilities, and abilities appear to be a challenge for the companies (PwC, 2016; Haseeb et al. 2019a; Haseeb et al.2019b; Ciobanu et al., 2019). Nevertheless, the recognition of the potential of the workers are equally important because the employees being trained but not given the opportunity to use their own creativity could limit their effectiveness. Li et al. (2019) argued that the sharing information and knowledge improve the skills set of the workers in the manufacturing sector. It is interesting finding, but there is still need for investigating it from the service sector. Cotteleer and Sniderman (2017) argued that there are other forces of change that are more predominantly affecting the operations of the enterprises. Smartly connected technologies are playing important role in the Industry 4.0 era to enhance the performance of the enterprises (Pauhofova et al., 2018). Nevertheless, this article did not find what those other priorities are in particular. The report of ATCC Finance (2015) revealed that the deadline to meet the client requirements, the reduction of cost through using manual labour rather than using digital methods installation to operate, and using orthodox method for execution of operations are some of the other factors that are more important concerns for the organisations.

The Industry 4.0 concept enables intelligent logistics organization as it provides data and tools for streamlining logistics operations and better risk management in the supply chain, from product logistics to inventory management to machine maintenance. The use of smart solutions makes it possible not only to monitor flow, emergency situations and the use of logistics infrastructure, but also to reduce power outages, reduce waste and implement intelligent pricing programs (Kergroach, 2017; Rahman et al, 2019).

Hereby, the role of public services in relation to improving the business environment is effectively important because it tends to improve the transparency within the operations (Dănăiață et al., 2014).

The concept of Industry 4.0 affects the implementation of logistics processes because:

1. Enables the use of resources and optimization of logistics processes: Industry 4.0 applications allow you to observe processes in real time, and the combination of machines, products and people allow for a very fast, efficient and fully automated response to emerging challenges during the flow of goods. Tracking the flow of resources is becoming more transparent, thanks to which it is possible to accurately estimate their quantity in the supply chain, and resources can be more effectively identified, optimized or eliminated. Streamlining the flow, including stock optimization, will allow you to increase the efficiency of logistics processes.

2. Better use of assets: thanks to Industry 4.0 technologies, it is possible to make optimal use of the logistics infrastructure. Constant and remote monitoring of

the state of the logistics infrastructure allows to reduce downtime in the flow by early detection of potential problems and continuous maintenance. Avoiding and correcting defects early can reduce costs and increase the efficiency of logistics processes.

3. Labor productivity: Industry 4.0 technologies can contribute to an increase in the productivity of the logistics staff by reducing the time of processes and expectations between different stages.

4. Quality improvement: thanks to the implementation of the Industry 4.0 application, it is possible to support the quality of logistics processes, including logistic customer service, among others thanks to enabling real-time problem solving, advanced process control or error correction to reduce the occurrence of unstable activities and, as a consequence, additional costs.

The fourth industrial revolution has already begun, with the transformation of existing value chains and networks. Extensive connectivity allows machines, warehouse systems, logistics equipment and products to exchange information, stimulating autonomous operations and enabling mutual control of operations. The main promise of the industrial Internet is full transparency from supplier to customer and network processes. The study of Haseeb et al. (2018) found the impact of industry 4.0 technologies affecting the performance of the companies. However, the study didn't investigate the other variables that mediates the impact of Industry 4.0 technologies on the enterprises' performance. Previously, the studies investigated direct relationship while using one or the other variable to measure the indirect impact. Thus, based on the limitation of the earlier studies and future directions, we construct the framework, which brings various predictors as combined factors to investigate the multiple predictors mediating the relationship between Industry 4.0 and enterprises' performance.

2. Research Framework

2.1 Research Hypotheses

Following are the research hypotheses:

H1: Limited knowledge related to Industry 4.0 significantly mediates the impact of Industry 4.0 on the logistic enterprises' performance.

H2: Implementation barriers for Industry 4.0 significantly mediate the impact of Industry 4.0 on the logistic enterprises' performance.

H3: Recognition of potential changes related to Industry 4.0 significantly mediate the impact of Industry 4.0 on the logistic enterprises' performance.

H4: Benefit appearance time period significantly mediates the impact of Industry 4.0 on the logistic enterprises' performance.

H5: Preparing staff for challenges significantly mediates the impact of Industry 4.0 on the logistic enterprises' performance.

H6: Other priorities than introduction of Industry 4.0 significantly mediates the impact of Industry 4.0 on the logistic enterprises' performance.

H7: Industry 4.0 technologies has significant impact on the logistic enterprises' performance.

2.2 Research Methodology

One of the most essential part of the study is to employ appropriate method (Haque, Kot and Imran, 2019). This study considered cross-sectional research design while following quantitative deductive research approach to attain prime objective of the study. The data is gathered through a survey questions based on the Likert scale. The fair and equal representation of respondents in the survey is important to avoid biases (Haque, Aston and Kozlovski, 2018), therefore, using same approach, we combined different sampling strategies such as purposive sampling, referral, convenience, and area-cluster sampling to reach target audience in two different countries. In addition to that, there was no adequate sampling framework available thus, area cluster was preferred over stratified sampling and purposive sampling to have the equal and fair representation. Moreover, the mixed sampling strategies are effective in gathering response from large population. As a result, we attained fair and equal representation in Canada and Poland by having total 320 respondents (160 in each country). Different logistic enterprises were approached through network and connections by circulating on-line survey formed through Googledoc. We used SPSS 23.0 for statistical test and since we considered the multiple predictors within one construct, therefore, we used multiple regression test to determine the impact of predictors on enterprises' performance for numeric expression.

As part of the strategy, we visited some organisations in Canada and Poland during preliminary research to understand the trends and operations. We obtained the different variables found in two countries that are linked with Industry 4.0 technologies and logistic enterprises' performance, thus, we further confirmed that the elements in the literature as well as preliminary study were similar to larger extent. Thus, we used it in the survey to ensure there is construct, content and face-value validity. Total 600 questionnaires (300 in each county) were sent, which reflect 53% response rate. In three attempts, equal percentage was drawn.

The operationalization of constructs was made by reviewing the concepts of Industry 4.0 technologies adopted from the work of Imran et al. (2018) as the mentioned study has clearly defined the constructs to study it. The predictors were depicted from the work of Haseeb et al. (2019) which was used in this study to find their multiple mediation in relation to logistic enterprises' performance. Lastly, the construct operationalization contains the dimensions of logistic enterprises' performance from the work of Kot et al. (2018).

3. Results Analysis and Discussions

3.1 Descriptive Statistics

The detailed descriptive analysis of respondents' profile revealed that from Poland, majority of limited liability company (56%) participated in the study while from Canada, it was limited joint stock partnership (44%). Majority of the participating enterprises had (10-49) employees from both, Canada and Poland (61% and 53%). The

leading business profile in this study falls into "transport" (72% in Canada and 62% in Poland). Majority of the participants were employees working in the logistic businesses in Canada and Poland (55% and 42%). Lastly, higher number of respondents confirmed that they are familiar with the characterizing the concepts of Industry 4.0 and are planning to launch it within their respective company (62% in Canada and 57% in Poland). All this information is given in Table 1.

Table 1.Descriptive Variables

Component	Country	Category	Frequency	%
Organizational and Legal form of company	Canada	Joint stock company	11	6.8
		Limited liability company	89	55.9
		General partnership	20	12.5
		Limited liability partnership	13	8.1
		Limited partnership	12	7.5
		Limited joint stock partnership	9	5.6
		Sole proprietorship	6	3.7
	Poland	Joint stock company	25	15.6
		Limited liability company	9	5.6
		General partnership	8	5.0
		Limited liability partnership	18	11.2
		Limited partnership	10	6.2
		Limited joint stock partnership	70	44.1
		Sole proprietorship	30	18.7
Number of employees	Canada	10-49	97	60.9
		50-249	41	25.6
		250 or more	22	14.5
	Poland	10-49	84	52.8
		50-249	62	38.2
		250 or more	14	11.0
Leading Business Profile	Canada	Transport	115	72
		Warehousing and inventory management	20	12.5
		Forwarding	15	9.3
		Packing and packaging	4	2.5
		Information services: providing information for planning, coordination, control of logistics processes		
		Third Party Logistics (3PL)	4	2.5
		Supply chain management	2	1.2
	Poland	Transport	99	62.0
		Warehousing and inventory management	11	6.8
		Forwarding	14	11.0
		Packing and packaging	16	10.0

Component	Country	Category	Frequency	%
		Information services: providing information for planning, coordination, control of logistics processes		
		Third Party Logistics (3PL)	15	9.3
		Supply chain management	5	3.1
Position	Canada	Owner / Co-owner/ Director/ Deputy Director	35	31.8
		Middle manager	26	16.2
		Low-level manager	11	6.8
		Employee	88	55.0
	Poland	Owner / Co-owner/ Director/ Deputy Director	41	25.6
		Middle manager	22	13.7
		Low-level manager	30	18.7
		Employee	67	42.0
Concept of Industry 4.0	Canada	No, I have never heard of it	22	13.7
		Yes, I have heard of it but I do not know what it is characterized by	11	6.8
		Yes, I know the details characterizing the concept	10	6.2
		Yes, I know the details characterizing the concept and we are planning to launch it in our company	99	62.0
		Yes, we are launching its assumptions/technologies in our company	18	11.2
	Poland	No, I have never heard of it	17	10.6
		Yes, I have heard of it but I do not know what it is characterized by	13	8.1
		Yes, I know the details characterizing the concept	19	11.8
		Yes, I know the details characterizing the concept and we are planning to launch it in our company	91	57.0
		Yes, we are launching its assumptions/technologies in our company	20	12.5

(Source: Author's own calculations based on the collected data)

a. Multiple Regressions

The model summary revealed that R2 for both countries is over 0.6, which means that over 60% variation in the logistic enterprises' performance is caused by predictors such as limited knowledge, implementation barriers, recognition of potential changes, benefit appearance time period, preparing staff of changes, and other priorities than introduction of industry 4.0. In depth, it showed that 63.4% variation in Canada and 61.2% variation in Poland, the variables in questions (predictors) cause variation in the logistic enterprises' performance (Table 2).

Table 2. Model Summary[a,c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.641[b]	.634	.554	1.28612
2	.637 [b]	.612	.549	1.38815

a. Country: 1=CANADA and 2=POLAND

b. Predictors: (Constant), Limited knowledge, Implementation barriers, Recognition of potential changes, Benefit appearance time period, Preparing staff for changes, Other priorities than introduction of Industry 4.0

c. Dependent Variable: Logistic Enterprises' Performance

(Source: Author's own calculations based on the collected data)

The ANOVA model showed that F= 37.80 for the Canada, which means that the explanatory power of the model is 37.80% while for Poland F= 38.02, reflecting 38.02% explanatory power (Table 3). Moreover, the sig value is less than alpha (Canada =0.000 < 0.05; Pakistan =0.000 < 0.05), indicating the value is statistically significant. Hence, the explanatory power of the model is acceptable in both countries as over one-third is explained by the model. The model is a good fit.

Since the R2 (regression) is higher as well as F (explanatory power) is acceptable, therefore, model is acceptable, we measure the multiple regression of the predictors on the dependent variables.

Table 3. ANOVA[a,b, a' b]

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression Residual Total	195.854 371.726 567.580	4 316 320	39.781 1.976	37.805	.000[c]
2	Regression Residual Total	196.391 395.372 591.763	4 316 320	38.0218 1.911	36.307	.000[c]

a. Country = 1.0 – CANADA

a'. Country = 2.0 – POLAND

b. Dependent Variable: Logistic Enterprises' Performance

(Source: Author's own calculations based on the collected data)

The statistical data revealed that limited knowledge about Industry 4.0 concepts has a statistically significant on the performance of logistic enterprises in Canada and Poland (=0.000 < 0.05, p < α; =0.000 < 0.05, p < α; Table 4).

Table 4.Coefficients[a, a,' b]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
	(Constant)	1.578	.621		2.541	.001
CANADA	Limited Knowledge	.083	.023	.66	3.608	.000
POLAND		.071	.033	.41	2.151	.000
CANADA	Implementation barriers	.426	.081	.37	5.259	.000
POLAND		.329	.069	.32	4.768	.000
CANADA	Recognition of potential changes	.311	.053	.44	5.867	.000
POLAND		.298	.062	.35	4.806	.000
CANADA	Benefit appearance time period	.341	.095	.31	3.589	.000
POLAND		.276	.091	.29	3.032	.002
CANADA	Preparing staff for challenges	.174	.082	.21	2.121	.001
POLAND		.169	.073	.23	2.315	.001
CANADA	Other priorities than introduction of Industry 4.0	.164	.081	.19	2.024	.002
POLAND		.153	.078	.13	1.961	.047

a. Country = 1.0 – CANADA
a'. Country = 2.0 – POLAND
b. Dependent Variable: Logistic Enterprises' Performance

In addition to that, the t-value is greater than 1.96; and, thus, the attained value falls into the critical region. Therefore, there is a statistically significant impact of limited knowledge on the logistic enterprises' performance of both Canada and Poland. Hence, we fail to reject hypothesis 1. Our findings showed that Industry 4.0 technologies is significantly mediated by the limited knowledge regarding Industry 4.0 which affect the logistic enterprises' performance in Canada and Poland. Interestingly, the standardized coefficient variation β=0.66 in Canada and β=0.41 in Poland is caused by limiting knowledge in case of single unit deviation from the standard. The variational impact in Canada is higher because β value is higher than Poland. Since, the statistically significant impact is established through present findings, therefore, this study supports the earlier reported findings of ATCC Finance (2015) while partially contradicts the work of Li et al. (2019). Hence, it is confirmed that the various types of technical and operational challenges are created for the logistic enterprises when there is inadequate knowledge and understanding about the Industry 4.0 concepts and key attributes. In other words, the findings of ATCC Finance (2015) is largely supported that despite digital transformation in the present era is promoting the concepts and knowledge of Industry 4.0, yet the better performances of the enterprises are difficult because of the limited knowledge about the adequate use of Industry 4.0

attributes. The implementation barriers related to Industry 4.0 statistically significantly affect the logistic enterprises' performance in Canada and Poland (=0.000 < 0.05, $p < \alpha$; =0.000 < 0.05, $p < \alpha$; Table 4). Similarly, t-value is also greater than alpha. Thus, implementation barriers has a significant impact on the performance of logistic enterprises in Poland and Canada. We fail to reject hypothesis 2. The standardized coefficient variation in Canada is β=0.37 and in Poland β=0.32 indicates that implementation barriers causes variation in the logistic enterprises' performance when there is a single unit deviation from the standard. Interestingly, the variation in Canada is higher than the Poland (β=0.37 >β=0.32). Since, the statistically significant impact is established through present findings, thus our findings are consistent with the work of Nagy et al (2018) as the present findings confirmed that several types of implementation barriers interlinked with the implementation of Industry 4.0 affect the operations and functioning of the enterprises.

Moreover, the study partially supports the work of Imran et al. (2018) that indirectly found the attributes of the Industry 4.0 in the logistic sector are subject to different types of internal and external barriers, which eventually causes the hinderance to top quality performance of the enterprises. Moreover, to some extent this study is aligned with the work of Stentoft et al. (2019) as we found that Industry 4.0 including transformation and implementation barriers reduce the chances of the SMEs to be ready for the digitalized process, which is a hinderance to effective and efficient performance of the enterprises, irrespective of the type of economy they commence their operations.

Recognition of potential changes statistically significantly affect the logistic enterprises' performance in Canada and Poland (Canada->*t*-value=5.867 > 1.96; Poland ->*t*-value=4.806; Canada -> =0.000 < 0.05, $p < \alpha$; Poland -> =0.000 < 0.05, $p < \alpha$; Table 4). We fail to reject hypothesis 3. Our findings are consistent to some extent with the findings of Li et al. (2019) that recognition of potential changes related to Industry 4.0 is effective in enhancing the performances of the enterprises where opposed the work of Haseeb et al. (2018) that argued Industry 4.0 drivers themselves are significant in affecting the performance of enterprises while changes are subject to alteration and it has non-significant impact on the process of operations. In addition to that, Li et al. (2019) also found that the recognition of changes is vital for succeeding in the business whereas the information and sharing knowledge is vital component in the process of recognizing changes. Since, their work was primarily focused on one specific region while this study used the comparative perspective, therefore, the new development improves the generalizability in the cross-cultural aspect. The deviation from the standard by one-unit led to recognition of potential changes cause positive variation in the performance of logistic enterprises in both; Canada and Poland. However, the variation caused in the logistic enterprises' performance in Canada is higher than Poland (β=0.44 >β=0.35). Again, it could be relate to the challenges of complexities that are created by the uncertainties and changes identified in the study of Li et al. (2019), whereas it could be effectively managed by the concepts of Industry 4.0 as to sharing information and knowledge to deal with such challenges during the implementation of Industry 4.0 features lead to attain competitive edge. The work of

Li et al. (2019) argued that such ability and tendency enabling the attainment of competitive edge in the market effectively improves the performance of the enterprises, thus, we support their work.

It is also found that benefit appearance time period has a statistically significant impact on the logistic enterprises' performance in Canada and Poland (Canada->*t*-value=3.589 > 1.96; Poland ->*t*-value=3.032; Canada -> =0.000 < 0.05, $p < \alpha$; Poland -> =0.002 < 0.05, $p < \alpha$; Table 4). Hence, we fail to reject hypothesis 4. Our findings support to some extent the work of Hermann et al. (2014) and Lasi et al. (2016) by confirming that time period is significant in determining the performance of the enterprises while contradicts the work of Cotteleer and Sniderman (2017) that changes are constant in affecting the performance therefore the time period is not critical but the situation and context are vital aspects, and this study found vice versa. Findings also reflect that logistic enterprises' performance is affected by the benefit appearance time period as positive variations are caused, but it is higher in Canada than Poland (Canada > Poland: β=0.31 >β=0.29).

Results showed that logistic enterprises' performance statistically significantly affect by preparing staff for challenges (Canada->*t*-value=2.121 > 1.96; Poland ->*t*-value=2.315; Canada -> =0.001 < 0.05, $p < \alpha$; Poland -> =0.001 < 0.05, $p < \alpha$; Table 4). This indicates that irrespective of the country, the preparing staff for challenges have significant impact on the logistic enterprises' performance. Thus, we fail to reject hypothesis 5 as the present findings are aligned with the earlier work of Haseeb et al. (2018), PwC (2016), and Li et al. (2019). The study findings support earlier work that suggested that one of the biggest challenges for the companies in the modern era is to prepare and retain the workers, especially when the Industry 4.0 concept and knowledge has gained the new heights for various sectors and industries.

Furthermore, the Stentoft et al. (2019) argument is supported by the present finding that it is one of the challenges for the companies to prepare the staff for different types of situations. Perhaps, the knowledge, skills, abilities, and capabilities of the workers through training program could be effective in dealing the challenges of volatile environment because it would be preparing them to overcome the challenges of connectedness, context, and complexities, which were previously argued by Haque, Aydin and Uysal (2017).

Nevertheless, their report argued that leaders have a role in preparing challenges while this study found no conclusive evidence to support or contradict this notion. However, the study finding of Li et al. (2019) that the sharing information and knowledge related to Industry 4.0 enables the workers to have more improved skills, which is the result of recognition of the potential of the workers being trained as well as given the opportunity to use their own creativity to be more effectiveness. Since, the findings of Li et al. (2019) was from the manufacturing sector limited to region specificity while this study further provide the confirmation from the service sector through comparative lens. Hence, this is a new insight to the existing literature. It further extends the findings by providing the results from two different economies' logistic enterprises. Interestingly, the impact of preparing staff for challenges are higher in Poland than Canada because β - value is greater there (β=0.21 <β=0.23).

Lastly, the findings of this study showed that other priorities than introduction of industry 4.0 have statistically significant impact on the logistic enterprises' performance in Canada and Poland (Canada->*t*-value=2.024 > 1.96; Poland ->*t*-value=1.961; Canada -> =0.002 < 0.05, $p < \alpha$; Poland -> =0.047 < 0.05, $p < \alpha$; Table 4). Thus, we fail to reject hypothesis 6 as the findings showed that the logistic enterprises' performance is highly affected by the other priorities than introduction of industry 4.0, which means that our findings are consistent with the work of Cotteleer and Sniderman (2017) that other priorities than the Industry 4.0 affect the operational performance of the enterprises.. However, their study failed to highlight what are those other priorities. Hence, this study further expanded the notion of ATCC Finance (2015) report by considering other priorities such as; "the deadline to meet the client requirements", "the reduction of cost through using manual labour rather than using digital methods installation to operate", and "using orthodox method for execution of operations" to examine the impact. Findings confirmed that all such factors have role in affecting the overall performance of the enterprises.

Therefore, this study supports the postulates reported by ATCC Finance (2015). Furthermore, the variation caused by this predictor it is higher in Canada than Poland because β - value is greater in first one than the later (β=0.19 <β=0.13).Through funnel approach, it is further found that respondents reported that the sharing information is one of the important aspects that could assist them in business operations and overcoming the challenges of the dynamic environment. They reported that the local government and regional administration could play an important role in the process by working as a key facilitator for the business through forming a network chain where all commerce activities are connection and business-oriented services promote and educate the information and knowledge to tackle the challenges of technologies.

Table 5. Direct Effect of independent variable on dependent variable

Hypothesis	Relationship	Country	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
H7	Industry 4.0 Technologies ->Logistic Enterprises' Performance	CANADA	0.329	0.114	2.885	0.002
		POLAND	0.215	0.109	1.972	0.048

a. Independent Variable: Industry 4.0 Technologies
b. Dependent Variable: Logistic Enterprises' Performance
(Source: Author's own calculations based on the collected data)

After establishing the impact of different interlinked variables within the logistic enterprises' performance in Canada and Poland, next step was to investigate the direct relationship between Industry 4.0 technologies (independent variable) and logistic enterprises' performance. The results showed that industry 4.0 technologies have statistically significant impact on the logistic enterprises' performance in Canada and Poland (Canada->*t*-value= 2.885 > 1.96; Poland ->*t*-value =1.972; Canada -> = 0.002<

< 0.05, $p < \alpha$; Poland -> = 0.048 < 0.05, $p < \alpha$; Table 4). Thus, we fail to reject Hypothesis 7. This study is aligned with the work of Haseeb et al. (2018) as we confirmed that Industry 4.0 technologies are significantly affecting the performance of the enterprises. However, this study goes beyond a step further by confirming not only the direct relationship between Industry 4.0 and enterprises' performance but considered the various other predictors that mediates the relationship between the variables of interest.

4. Conclusion and recommendations

The conclusion is drawn in the light of evidence that there are various challenges for the implementation of Industry 4.0 technologies within the logistic companies in both Polish and Canadian logistic enterprises. Furthermore, it is reported that public services for the business environment is essential for bringing transparency in operations and bridging the gap between logistic enterprises' performance and shared knowledge and communication. The public services for business environment bring quality results when the local administration work as a facilitator for the business to share knowledge and information. It is found that knowledge as well as implementation of Industry 4.0 concepts in both considered economies are statistically significant. In the due course, this study considered exploring the multiple predictors mediating the relationship between Industry 4.0 implementation and logistic enterprises' performance in Poland and Canada. Limited knowledge related to Industry 4.0 is found to statistically significantly mediate the relationship between Industry 4.0 technologies and logistic enterprises' performance.

Thus, the findings further extend the previous empirical findings of ATCC Finance (2015) report. In addition to that, from the comparative lens, it is found that the variational impact in Canada is higher than Poland. It is also found that implementation barriers related to Industry 4.0 significantly affect the relationship between Industry 4.0 technologies and performance of the enterprises. Therefore, the study is aligned to certain extent with the work of Imran et al. (2018), Nagy et al (2018), and Stentoft et al. (2019). Again, the variation is higher in Canada than Poland, reflecting that such implementation barriers have higher impact in Canada as compare to Poland.

The recognition of potential changes related to Industry 4.0 significantly mediates the relationship between Industry 4.0 technologies and performance of enterprises in logistic businesses in Canada and Poland. The work of Haseeb et al. (2018) is contradicted while Li et al. (2019) is supported as the changes impact the effectiveness in improving the performances. The study showed that sharing knowledge and information is essential feature in the process of recognizing changes. Like the findings of Hermann et al. (2014) and Lasi et al. (2016), it is found that time period has a role in mediating the effect between Industry 4.0 technologies and performance of enterprises. The positive variations are caused by the benefit appearance, which is higher in Canada than Poland, reflecting the developed economy has a better time period appearance for implementing the Industry 4.0 technologies.

The staff preparation for meeting and overcoming the challenges are equally important aspect to ensure the performance of the enterprises. Since, in this study, both Polish and Canadian logistic enterprises' performances are significantly affect due to the ability to prepare staff for various types of challenges, therefore it is confirmed that the preparation of staff to mediate the relationship between Industry 4.0 technologies and performance of the companies. This also means that present study supports the recent work of PwC (2016), Haseeb et al. (2018) and Li et al. (2019). Furthermore, the previous findings were limited to manufacturing firms while this study extend the findings from service industry, especially from the comparative lens.

Indirectly, the environmental challenges such as, context, connectedness, and complexities are affecting the workforce is established through this study, which affect the workers and eventually the performance of the companies. The employees' inner capabilities and creativity are essential features that prepare employees to tackle various types of challenges related to implementation of Industry 4.0 technologies. Interestingly, the Polish logistic firms are more effective than the Canadian firms in preparing the staff for such challenges. It is also found through this study that other priorities such as, "the deadline to meet the client requirements", "the reduction of cost through using manual labour rather than using digital methods installation to operate", and "using orthodox method for execution of operations" in Canada are more visible than Poland, which mediates the relationship between implementation of Industry 4.0 technologies and performance of enterprises. After assessing the multiple predictors as mediators, it is confirmed that the implementation of Industry 4.0 technologies has a significant impact on the performance of logistic enterprises in Canada and Poland. Since, we found a significant direct relationship between variables of interest, therefore, we support the work of Haseeb et al. (2018) in this regard. However, the comparison revealed that, the impact of Industry 4.0 technologies on the performance of logistic enterprises.

Based on the current findings, business-oriented services of the public sector shall focus on the environment related authorizations to ensure that there is consistent collaboration between the public services agencies and the private logistic businesses. The public services shall make it mandatory for the business to submit data to the statistical office so that there could be more information about smooth implementation of the Industry 4.0 technologies. Furthermore, the public services for the business shall also ensure that logistic enterprises have proper workshops and seminars to educate and promote the use of modern technologies. The public services for the business environment shall also make it mandatory for the enterprises to use Information and Communication Technologies (ICTs) by making a domain for the logistic enterprises and ensure that the networking is strengthened by using ICTs so that there is higher sharing of knowledge and information regarding latest technologies. The local administrations could be considered as facilitators to connect the businesses to main domain so that latest information could be attained in order to overcome various types of IT related challenges.

It is recommended to the logistic enterprises in both economies to ensure that other priorities are dealt in a manner so that it does not hinder the implementation of

the Industry 4.0 technologies during the operations. This could be achieved by using the strategy of Li et al. (2019) that is "sharing information and knowledge" with the internal customers. In addition to that, preparing the human capital to tackle different types of challenges, by following the strategy of Stentoft et al. (2019) so that according to the situation, employees adopt and alter their approaches. The preparation of the staff for dealing with the challenges of the context, connectedness, and complexities could also be a better approach. In this aspect, the strategy of Haque et al. (2017) that investing in the leaders/supervisors/managers that have the vast experience of working in global organizations. This way the implementation of the Industry 4.0 technologies would be more doable because there is no substitute to the experience and working at the global platform tends to enhance the working experience of personnel to respond to contingent challenges.

Despite the best of our effort, there are some limitations in this study as we only considered to economies to assess the relationship between variables of interest. The future researchers shall further extend it by including the different range of economies. It would be interesting to compare the developed, middle ranged and emerging economies' manufacturing as well as service sectors to have more conclusive findings. The sample size is adequate but considering the size of Canada as a country, it appears a very small representation of the country to only include 160. In this regard, the sampling technique should be improved in the future studies by using the area-cluster sampling and quota representation to have at least one-third ratio of the regions' representation. We only employed a survey to gain quantitative aspect. In other words, the emphasis was on the factual truth, whereas the embedded hidden aspects that are often explored through qualitative findings are effective in providing useful truth.

The future researchers shall consider the use of qualitative methods such as one-on-one interviews with the individuals and focus group interviews with the experts to further explore the phenomenon (i.e. attaining useful truth), which is presently limited to mathematical objectivity (i.e. obtained factual truth).

Authors Contributions

The authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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