INDUSTRY 4.0, LEAN MANAGEMENT AND ORGANIZATIONAL SUPPORT: A CASE OF SUPPLY CHAIN OPERATIONS

Tiep N.C., Oanh T.T.K., Thuan T.D., Tien D.V., Ha T.V.*

Abstract: Currently, Industry 4.0 is considered as the essential improvement of business processes that could improve the lean management along with high organizational support and effective supply chain practices. Thus, the aim linked with the current article is to examine the role of Industry 4.0 in the business processes and its impact on lean management. The purpose also includes the investigation of mediation impact of supply chain operations reference model (SCORM) among the nexus of the role of Industry 4.0 in business process and lean management along with the examination of moderating role of organizational support among the nexus of SCORM and lean management. The researchers and questionnaires have selected the quantitative method of data collection have been used to gather the data from the respondents, while smart-PLS has been executed for analysis purpose. The results revealed that positive association had been found among the nexus of the role of Industry 4.0 in the business processes and lean management. The results also exposed that SCORM is positively mediating among the nexus of the role of Industry 4.0 in the business processes and lean management while organizational support positive moderated among the nexus of SCORM and lean management. These findings provided the guidelines to the policymakers that they should enhance their focus on the implementation of Industry 4.0 in the organization that could lead the organization towards success.

Keywords: supply chain operations reference model, industry 4.0, lean management, organizational support.

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* **Nguyen Cong Tiep** Dr. Vietnam National University of Agriculture (VNUA), Trau Quy, Gia Lam, Ha Noi; Vietnam. **Thai Thi Kim Oanh** Dr. Economics Department, Vinh University (VU), Vinh City, Vietnam. **Tran Duc Thuan** Dr. Dong Nai Technology University (DNTU), Bien Hoa City, Vietnam. **Dinh Van Tien** Prof Dr. Ha Noi University of Business and Technology (HUBT), Vinh Tuy, Hai Ba Trung, Ha Noi. **Thai Van Ha** Dr. Ha Noi University of Business and Technology (HUBT), Vinh Tuy, Hai Ba Trung, Ha Noi.
✉ corresponding author: thaithikimoanhkt@gmail.com
✉ nctiep@vnua.edu.vn; tranducthuan@dntu.edu.vn; dvtien.napa@yahoo.com; vanha280182@gmail.com; phuongcknn@cam.edu.vn

Introduction

The world has become a global village. The advancement in technology brings the revolution in every aspect of life. The rapid developments in technology affecting the industry world strongly. With time, new concepts are taking place in the industry world. These new ideas are results in increasing the competition at a rapid pace. One of the concepts which throwing a positive effect on the manufacturing concern industry is Industry 4.0.

The definition of Industry 4.0 is linked to the usage of the internet in the manufacturing industry of things and associated technology. It is also referred to as the commercial internet of things. Initially developed by the German government and research agencies and industry organizations, Industry 4.0 aims at a digitally integrated future by real-time connectivity between computers, industries, consumers and whole supply chains (Yadav, Luthra, Jakhar, Mangla, & Rai, 2020). This makes for fast pace variability and profitability in the production of industrial value possible. The Vietnam Government, with the implementation of Industry 4.0, attempts at addressing two trends, thus ensuring future productivity of the German industry. Firstly, improvements in the Vietnam industry's environmental conditions and, secondly, related technical developments from the IT market. This opposes, however in part the idea of lean management, which in its fundamental methodology is IT-free and mostly regarded as the last movement before Industry 4.0 appeared. Although lean management encourages output consistency, while industry 4.0 promotes commodity uncertainty, the overarching priorities for improving efficiency, consumer loyalty and profitability remain similar (Villalba-Diez, Zheng, Schmidt, & Molina, 2019). Moreover, Industry 4.0 was largely seen from a technical point of view, with its theoretical promise rather than the realistic advantages of integrating economic and technological viewpoints. The technical conversions needed to build Industry 4.0 are supposed to contribute to both management and organization (Tortorella, Giglio, & van Dun, 2019b). These were not, however, viewed comparably. In particular, the effect of Industry 4.0 on supply chain management remains uncertain. It seems like there are several technologies showcases in current literature, though an outline is still missing. The study query discussed in this report is, what is the actual status of the lean management implementation of Industry 4.0 in the various areas of the supply chain?"

To help appreciate Industry 4.0's consequences for the management of the supply chain, this study adopts the viewpoint of the SCOR model to cover organizational, architecture and policy issues comprehensively without disregarding the specific process phases. Since the SCOR model is an existing model that defines practices in

study and practice processes and supply chain management while minimizing uncertainty, the findings are comparable and can be generalized appropriately.

Literature Review

In a globalized and digitally linked environment, the capacity to produce individual and industrial goods is essential to growth. Customers are accustomed to obtaining items regarding their requirements. This intense consumer demands increase the variety of variants and increase the difficulty of the manufacturing environment. The Toyota Manufacturing Infrastructure is the commercial region (TPS). Toyota Motor Corporation's manufacturing philosophy in the last century seeks to minimize duplication in the supply chain to reduce lead times. Via its incorporation of this philosophy and its permanent emphasis on consumer value through an ongoing development phase, Toyota has become a global pioneer in the automotive field. The TPS is now well established as lean management (LM) or lean manufacturing and is commonly used in different industries as a norm (Ciano, Dallasega, Orzes, & Rossi, 2020; Fernández-Caramés, Blanco-Novoa, Froiz-Míguez, & Fraga-Lamas, 2019).
The relatively recent area of analysis Industry 4.0 provides another opportunity to solve the rising difficulty of development (I4.0). It aims to increase accountability by linking each feature in the output digitally. It is focused on cyber-physical systems (CPS) that coordinate the process of generating value. Another central aspect of I4.0 is the development of an Internet of Things (IoT), which enables the communication of data globally in real-time. Both paradigms of development, i.e. LM & I4.0, are promising to address potential industrial problems. Therefore, there is the issue if and how these innovations will be mutually supportive. This paper is also expected to add to this field of study. More explicitly, the authors address the following research questions: How can LM and I4.0 be mutually supplementary on a logical level? What I4.0 software will help such lean methods? This paper offers an initial description of the related groundwork and proposes to link LM with I4.0 in a philosophical way (Hayhoe, Podhorska, Siekelova, & Stehel, 2019; Shahin, Chen, Bouzary, & Krishnaiyer, 2020). Current literature is thus divided into three streams of study. It is also seen how Industry 4.0 software will lead to the optimization of such lean approaches such as just-in-time (JIT), complete output maintenance, and Poka-yoke. This developmental approach to developing lean practices can help scientists and practitioners create a scalable production framework for an evolving climate. Finally, a case-by-case application for machine learning condition monitoring (CM) and cloud computing to TPM demonstrates how these paradigms will function together to boost

electrical drive generation. Finally, the writers explore the definition formed and summarize the main results (Madsen, 2019; Rane & Narvel, 2019).

Industry 4.0 is linked to the usage of the internet in the manufacturing industry of things and associated technology and is also referred to as the commercial internet of things. The advent of the fourth industrial revolution is aligned with Industry 4.0. It demonstrates the recent trend in automation technology in the manufacturing sectors, which is becoming increasingly common. The significant innovations for revolutionary production thinking are (1) CPS, (2) IOT and (3) Cloud storage (Basu & Dan, 2019; Ivanov, Tang, Dolgui, Battini, & Das, 2020). Modern manufacturing processes should also be able to manage the uncertainty of the development phase by utilizing the CPS because of changing consumer needs (Tupamahu, Ghozali, & Basuki, 2019). This enterprise that combines cyber and physical processes is also widely recognized as an intelligent farm. IOT helps develop networks to promote the development of an intelligent factory. Cloud output would make a significant addition to Industry 4.0. It uses a massively dispersed network of services (Li, Dai, & Cui, 2020; Salam, 2019; Tortorella, Giglio, & van Dun, 2019a). Industry 4.0 is based on CPS. CPS interacts with computational institutions in conjunction with physical structures and procedures in the enterprise to accomplish the different aims of organizations by collecting data and processing data through the internet. The physical and software elements are interlinked to each other and function at various spatial and temporal scales. Through implementing CPS, computers can connect, and decentralized communication networks can maximize the usage of resources in the manufacturing phase. Today, the enterprise must be effective, profitable, and sustainable to succeed in the sector, Industry 4.0 achieves this aim by knowledge and manufacturing digitalization. In terms of satisfying consumer demands, the long-term and short-term competitive effect of Industry 4.0 on production and services in the global markets is enormous and more effective. Industries worldwide have reacted successfully (Bruneckienė et al., 2020; Istianingsih et al., 2020; Labolo et al., 2020; Lentner et al., 2020).

Organizational support plays a vital role in the success or failure of any project. The more organizational support results in the enhancement of organizational performance. Whether the organization is manufacturing or services concern, organizational support is necessary for the betterment of the organization. If the organization is a manufacturing concern, then it is in more need of organization support. The entire manufacturing process had strong dependence over organizational support. Literature witness that there is a strong association between organization support and lean management (Kuper, 2020). The only and prima aim to apply the lean management approach is to enhance organizational performance. If the concept of lean management

gets real support from the organization, this will result in a rapid improvement in organizational performance. There is an association reported between organization support and lean management. Following are the hypotheses derived from the above debate:

H1: Industry 4.0 (Make process) positively associated with lean management in the manufacturing industry of Vietnam.

H2: Industry 4.0 (Plan process) positively associated with lean management in the manufacturing industry of Vietnam.

H3: Industry 4.0 (Source process) positively associated with lean management in the manufacturing industry of Vietnam.

H4: SCORM acts as a mediator on the association between Industry 4.0 (Make process) and lean management.

H5: SCORM acts as a mediator on the association between Industry 4.0 (Plan process) and lean management.

H6: SCORM acts as a mediator on the association between Industry 4.0 (Source process) and lean management.

H7: Organizational support moderates the relationship between SCORM and lean management.

Materials and Methods

The purpose of the ongoing research is to investigate the role of Industry 4.0 in the business processes and its impact on lean management along with the investigation of mediation impact of SCORM among the nexus of the role of Industry 4.0 in business process and lean management and also the examination of moderating role of organizational support among the nexus of SCORM and lean management. The researchers and questionnaires have selected the quantitative method of data collection have been used to gather the data from the respondents. The employees of manufacturing organization of Vietnam who are linked with the supply chain and technology adoption process are the respondents of the study. A simple random sampling has been used to select the respondent to distribute the surveys. A total of 420 surveys have been sent to the respondents, but after fifteen days, only 290 were returned that were used for analysis and represented about 69.05 per cent rate of response. In addition, smart-PLS has been executed for analysis purpose because the purpose of the study is hypotheses testing along with complex model. The variables that have been used one predictor such as the role of Industry 4.0 in the business process that has three dimensions named as to make the process (MP), plan process (PP) and source process (SP) all of the dimensions have three items. In addition,

supply chain operations reference model (SCORM) has been used as the mediator that has five items while organizational support (OS) has been used as a moderator that has six items (Karatepe & Aga, 2016) and lean management (LM) has been used as a dependent variable that has four items. These variables have been mentioned in Figure 1.

Results

The results show the assessment of measurement with the help of Alpha, composite reliability, AVE and Heterotrait Monotrait (HTMT) ratio along with the structural model with the help of path analysis. The convergent validity shows the relationships among items and values show that valid convergent validity and high nexus among items because values of loadings along with Ave are larger than 0.50 while CR and Alpha values are bigger than 0.70. These are shown in Table 1.

Table 1. Convergent validity

Items	Loadings	Alpha	CR	AVE
LM1	0.831	0.852	0.900	0.693
LM2	0.834			
LM3	0.848			
LM4	0.816			
MP1	0.833	0.900	0.939	0.837
MP2	0.953			
MP3	0.952			
OS1	0.887	0.845	0.818	0.534
OS4	0.666			
OS5	0.673			
OS6	0.672			
PP1	0.888	0.873	0.922	0.797
PP2	0.895			
PP3	0.895			
SCORM1	0.935	0.944	0.958	0.820
SCORM2	0.860			
SCORM3	0.933			
SCORM4	0.936			

SCORM5	0.859			
SP1	0.924	0.954	0.970	0.916
SP2	0.971			
SP3	0.976			

The discriminant validity shows the relationships among variables and values show that valid discriminant validity and low nexus among variables because values of Heterotrait Monotrait (HTMT) ratio are less than 0.90. These are shown in Table 2.

Table 2. Discriminant validity

	LM	MP	OS	PP	SCORM	SP
LM						
MP	0.571					
OS	0.225	0.271				
PP	0.433	0.408	0.246			
SCORM	0.558	0.889	0.263	0.394		
SP	0.443	0.518	0.544	0.420	0.510	

The results revealed that positive association had been found among the nexus of the role of Industry 4.0 in the making process, plan process and lean management in the manufacturing industry of Vietnam and accept H1 and H2. However, the results revealed that insignificant association has been found among the nexus of the role of Industry 4.0 in the sourcing process and lean management and reject H3. In addition, the results also exposed that SCORM is positively mediating among the nexus of the role of Industry 4.0 in all the business processes and lean management and accept H4, H and H6 while organizational support significantly moderated among the nexus of SCORM and lean management and accept H7. These links are highlighted in Table 3.

Table 3. Path analysis

Relationships	Beta	S.D.	t-statistics	p-values
MP -> LM	0.230	0.084	2.725	0.004
PP -> LM	0.197	0.065	3.038	0.002
SCORM -> LM	0.159	0.089	1.776	0.039
SCORM*OS -> LM	-0.192	0.060	3.206	0.001
SP -> LM	0.127	0.096	1.319	0.095
MP -> SCORM -> LM	0.120	0.068	1.765	0.040

PP -> SCORM -> LM	0.107	0.039	2.744	0.038
SP -> SCORM -> LM	0.116	0.041	2.829	0.035

Result Discussions

The results have revealed that the nature and quality of make processes with the help of Industry 4.0 have a positive association with the performance of lean management in the manufacturing industry of Vietnam. These results are in line with the previous studies of Cabral, Grilo, and Cruz-Machado (2012) which shed light on the point that if make processes are carried out properly, they will prove to be much beneficial for the lean management. The results have also indicated that the under Industry 4.0 concept the planning process in the industries put a positive impact on the working of lean management. These results match with those of past studies of Salah, Rahim, and Carretero (2010) according to which the improvement in the planning process leads to improvement in lean management. Similarly, the findings of the paper have represented that the source processes under Industry 4.0 have a positive association with lean management. These findings are in line with the past studies of (Singer & Becker, 2013), which also reveal that the better execution of source processes improves lean management. In the same way, the results have exposed that the SCORM is an appropriate mediator between make processes and lean management. These results are supported by studies of Liu, Huang, Mokasdar, Zhou, and Hou (2014) which show that the improvement in make processes helps in the implementation of the SCORM which further improves the performance of lean management. In addition, the findings of the study have indicated that SCORM is a considerable mediator between plan processes and lean management. These results match with the studies of Verdouw, Beulens, Trienekens, and Wolfert (2010), which also represent the SCORM as a mediator between the same variables. Furthermore, the results have also indicated that SCORM plays a mediating role between source processes and lean management. The studies approve these results of Zhou, Benton Jr, Schilling, and Milligan (2011). Besides, the results have revealed that organizational support is a considerable moderator between the supply chain reference model and lean management. These results agree with the results of past studies of Taherimashhadi and Ribas (2018).

The current study has made both theoretical and empirical implications. As far as the theoretical implication, a lot of contribution has been made to the literature on industry management. This paper is an initiation to introduce the importance of the Industry 4.0 concept. It implies that Industry 4.0 brings improvement in several processes like make processes, plan processes, and source processes. This study attempts to introduce the SCORM as a mediator and organizational support as a moderator simultaneously. The

study makes an empirical implication for it guides industrial management to apply lean management in the industry more efficiently with the implementation of Industry 4.0 concept in making processes, planning processes, and source processes. The study makes it clear to the industrial management with the SCORM and organizational support the performance of lean management.

Conclusion and Recommendations

In the conclusion of the study, it can be said that the Industry 4.0 concept improves different industrial processes with technology. The make processes, plan processes, and source processes are improved under this concept. The paper examines that make processes are in positive relation with lean management. The improvement in the make processes leads to improvement in the performance of lean management. Moreover, the results indicate that plan processes under Industry 4.0 impart positive influences on lean management. Similarly, the processes to identify, manage, and utilize different organizational sources are considerably in positive association with lean management. The study analyses that the SCORM plays an appropriate mediator between make processes, plan processes, and source processes and lean management. Besides, organizational support is a significant moderator between SCORM and lean management.

The current study has several limitations despite its detailed description of the concept Industry 4.0 and thereby the improvement in making processes, planning processes, and source processes which lead to lean management. The implementation of the concept of Industry 4.0 improves many other processes of the industry which are left by this study unaddressed. Thus, it is recommended to future scholars to address all the processes improved by the implementation of the concept of Industry 4.0 and positively affect the performance of lean management. Moreover, the data for the support of this study has been collected from a single source while future academics should acquire data from more than one source.

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PRZEMYSŁ 4.0, LEAN MANAGEMENT I WSPARCIE ORGANIZACYJNE: PRZYPADEK OPERACJI ŁAŃCUCHA DOSTAW

Streszczenie: Obecnie Przemysł 4.0 uważany jest za zasadnicze usprawnienie procesów biznesowych, które mogłoby usprawnić szczupłe zarządzanie przy jednoczesnym wysokim wsparciu organizacyjnym i efektywnych praktykach łańcucha dostaw. Zatem celem związanym z niniejszym artykułem jest zbadanie roli Przemysłu 4.0 w procesach biznesowych i jego wpływu na lean management. Celem jest również zbadanie wpływu mediacyjnego modelu referencyjnego operacji łańcucha dostaw (SCORM) na splot roli Przemysłu 4.0 w procesach biznesowych i szczupłym zarządzaniu, wraz z badaniem moderującej roli wsparcia organizacyjnego w powiązaniu SCORM i lean zarządzanie. Badacze i kwestionariusze wybrali ilościową metodę zbierania danych, która została wykorzystana do zebrania danych od respondentów, natomiast smart-PLS został wykonany do analizy. Wyniki ujawniły, że pozytywny związek został znaleziony wśród splotu roli Przemysłu 4.0 w procesach biznesowych i szczupłym zarządzaniu. Wyniki pokazały również, że SCORM pozytywnie pośredniczy w powiązaniu roli Przemysłu 4.0 w procesach biznesowych i szczupłym zarządzaniu, podczas gdy wsparcie organizacyjne jest moderowane pozytywnie wśród powiązań SCORM i lean management. Ustalenia te dostarczyły wskazówek dla decydentów, że powinni oni skupić się na wdrażaniu Przemysłu 4.0 w organizacji, która może poprowadzić organizację do sukcesu.

Słowa kluczowe: model odniesienia operacji łańcucha dostaw, przemysł 4.0, szczupłe zarządzanie, wsparcie organizacyjne.

工业 4.0，精益管理和组织支持：以供应链运营为例

摘要: 当前，工业 4.0 被认为是业务流程的必要改进，可以改进精益管理以及高水平的组织支持和有效的供应链实践。因此，与当前文章相关的目的是研究工业 4.0 在业务流程中的作用及其对精益管理的影响。目的还包括调查工业 4.0 在业务流程和精益管理中的关系中的供应链运营参考模型（SCORM）的中介影响，以及检验 SCORM 和精益之间的组织支持的调节作用管理。研究人员和调查表选择了定量的数据收集方法，用于从受访者那里收集数据，而出于分析目的执行了 smart-PLS。结果表明，在工业 4.0 在业务流程和精益管理中的作用之间存在正相关关系。结果还显示，SCORM 在工业 4.0 在业务流程和精益管理中的作用关系中起着积极的中介作用，而组织支持在 SCORM 和精益管理的关系中起了积极的调节作用。这些发现为政策制定者提供了指导方针，他们应加强对组织中工业 4.0 实施的关注，这可能会导致组织走向成功。

关键字: 供应链运作参考模型，工业 4.0，精益管理，组织支持。