

Why Industry 4.0 Adoption is Unavoidable for Sustainable Performance of Organizations?

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Abstract

The purpose of this research is to endorse the importance of the fourth industrial revolution and its adoption in terms of organizational performance. In this study, we have discussed that the adoption of Industry 4.0 (I4A) parameters can improve production outcomes and reduce operational wastes. In order to comprehend whether Industry 4.0 parameters are feasible to accomplish, organizations should get valuable guidelines by differentiating the production outcomes vide pre and post-technological implementation. It has been revealed that organizations with industry 4.0 lean and sustainable practices have achieved more substantial upshots in social, economic, operational, and environmental performance i.e. overall Organizational Performance (OP). Likewise, prevailing global trends have indicated that innovative performance and adoption of Industry 4.0 technologies have become 'unavoidable' in the business arena, thus providing the sign to companies to start embracing developments related to process optimization in order to sustain or even reinforce the competitiveness. Conclusively, organizations should not only emphasize process automation but also introduce smart and credible systems for better outcomes.

Keywords: Industry 4.0 adoption; innovation performance; sustainability; green practices; organizational performance.

JEL Classification: L50

Organizations should also focus to incorporate Sustainability (SUS) and Green Practices (GP) through technological Innovation Performance (IP) so that operational, economic, and environmental performance could be enhanced. The empirical results of this study have proposed the academic, social, and managerial implications while adopting the viable parameters of the fourth industrial revolution. The data was collected from 297 respondents of Supply Chain Companies and Smart-PLS was used for analysis.

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1. Introduction

In today's industrial environment, where concepts of smart factories are consolidating their application in companies, it is still necessary to approach management decision-making from a perspective that encompasses all aspects of sustainability without losing sight of the social return to which they must contribute. Basically, Industry 4.0 is a German originated peculiar concept of business automation, whose importance is the implication of innovation for proficient outcomes in production. Presently, the idea of smart production in smart factories is getting reasonable attention for its application in organizations, it is still important to get forward the decision making according to a viewpoint that incorporates sustainability aspects without deviating the social re-visit of which they should contribute (Naderi et al., 2019).

Industry 4.0 made smart industrial facilities and drove another production worldview dependent on the adoption of new innovations with respect to digital frameworks, augmented and virtual reality, cloud computing, the Internet of Things and the Internet of Services, etc. (Robert et al., 2020). In the light of different investigations the contextual results show that lean practices uphold efficacious adoption of I4.0 advances; acquainting such technological innovations are connected with fostering another sort of job profile; and more significant levels of industry 4.0 adoption which make an increased requirement for supportive or non-technical aptitudes (Cimini et al., 2021).

In business development organizations, refined parameters are adopted for the provision of supplies to the desired market places in appropriate quantity and serviceable condition by adopting lean parameters. There is a need to display models of how innovation capacity, competitiveness, and business growth can be built not solely from digitalization, supply chains literature, strategic management, and exploratory research, but integrating into business for scope embedded innovation and strategy within the industry 4.0 while thinking and acting in a smart way and becoming a part of smart society (Gerlitz, 2017).

One of the most significant challenges of Industrial Revolution 4.0 is the awareness and understanding of businesses about the change. Organizations must adapt and actively change their business operations, improve skills, and constantly apply technology. Numerous manufacturing ventures are perceiving the new innovations dependent on the establishment of the Industrial Revolution 4.0, which is altogether disturbing the current value chain of enterprises and makes a totally different method for maintaining a business (Nguyen & Luu, 2020). In terms of cognitive economy, it is important to assure quality perspective in Industry 4.0, which will animate the positive impact of the variables of manufacturing and industrial designing on the economy (Matytsin & Rusakova, 2021).

The implementation of Industry 4.0 is transforming the past trends of mechanical and electrical products because of smart services and products, into the items that contain sensors, programming's, hardware, information stockpiling, chip, and availability to release another rush of a contest wherein the customary traditional companies will make some intensive moments to get along. From a competitive perspective, product differentiation will be created through smart and savvy products, dynamic price value setting, customer relationship as well as segmentation (Sony, 2020).

The study is important with respect to the organizations and their subsequent supply chain strategies they adopt. The competencies prevailing among market players seek organizational capacities for further exploration of business opportunities. For such motives, the innovative capabilities of managers lead the organization towards progression and development. Likewise, business productivity is increased by implementing technological innovations. Sustainable green practices can be considered as a new, yet disregarded capacity of management operations. These can be ignored on the basis that typically lesser is known with respect to frameworks, in spite of global norms and environmental perspectives to environment, wellbeing and health and safety which have been observed (Yacob et al., 2019). Industry 4.0 and sustainability are significant points of discussion in manufacturing organizations. In any case, the association between these two ideas is less investigated in the literature. In prevailing business scenarios, the next generation of production companies is enormously affected by the dynamic nature of information technologies. Conclusively, the objective of this research criticizes I4.0 drivers to inculcate sustainable concepts in supply chains (Luthra et al., 2020).

Supply chain design and stable production consortiums should be set up to decrease the recurrence of supply chain interludes and to expand the adaptability to work with inappropriate underlying risks (Zhou et al., 2020). Sustainable practices can become good means to represent business obligations to companies from being receptive in handling the environmental pollution and squander and other feasible endeavors, to proactively adopt the accountability of business from raw components to the ultimate product disposal (Zailani et al., 2012). Jabar et al. (2011) have given the comments in their research paper that organizational performance is an important need for the development of the new product in Malaysian manufacturing industries. The authors have discussed the relationship between the strategic alliance partners. They do the agreements in order to grow better in the market and plan for further exploration to get the benefit.

In China, public authorities have given guidelines in sustainable perspective, suggesting that green development is basic to decrease the burden on climate or to diminish the cost and increase productivity. Generally, for small and medium-sized firms, significant expenses of sustainable products make it hard to accomplish green objectives, causing many firms to help out their supply chain network partners on green initiatives (Li et al., 2020).

Globalization has increased the number of customers who are environmentally cognizant and desiring for sustainable and green initiatives (Yacob et al., 2019). Government should develop environmental policies for green innovation and provide reasonable guidance to enterprises, as such policies have a decisive influence on the implementation of green innovation performance (Yang & Lin, 2020). We can strongly support the proposition that environmentally innovative practices bring economic, environmental, and operational benefits when compared to other companies (Zhu et al., 2012).

In industry 4.0, data management and cyber security have been handled by blockchain technology where trust has been acquired technologically. Information sent via automated protocols should be checked and enabled with zero tolerance for transparency endurance, limiting the threat of information debasement (Howson, 2020). Proactively looking through the supply chain network for resourceful network accomplices permits supervisors to stay up to date with the most recent innovations and processes (Aslam et al., 2020).

Green process innovations endeavor fuzzily and affect the production cost. There are various schools of thought portrayed in literature, as indicated by which process innovation can emphatically affect adverse consequences on the marginal cost of production (Liu & Giovanni, 2019). Business progression is distinguished as a quest for inventive and new solutions reporting specific needs. Organizations that are more curious and working on their development, should continually foster comprehensive strategies for new products (Ungerman et al., 2018). Thoughtfulness regarding environmental sustainability addresses fundamental issues for the organizations to culminate the environment into strategical preferences by delivering explicit developments that have ensured environmental upshots. Implementation of green practices addresses an extraordinary challenge for non-green organizations since it consistently requires the procurement of new resource competencies that vary altogether from their prevailing capabilities (Calza et al., 2017).

In supply chains organizations, every member is to perform efficiently to create value as per job requirements. The accomplishment of sustainable green practices discloses the company's absorptive behavior capacity of outer information and its connections to skillful internalities. (Arfi et al., 2018). Green Innovations are increasingly more explicit as a way of supporting upper notch's, meeting the prerequisites, working on a corporate response, or separating from contenders (Albort-Morant et al., 2018). Therefore, green practices ultimately affect firms' financial and on green execution (Ahmed et al., 2018).

Nexus to the abovementioned lines, the research objectives of this study are narrated as needed to identify the attributes to increase the economic, operational, and environmental performance whether the organization is desired for / facilitated with I4.0 components. Secondly, an evaluation of the sustainable role of Green Practices in organizational economic, operational and environmental performance is required to explore.

Followed by the objectives, the following research questions have been identified for exploration; (1) What are the driving forces (motives) which stimulate the organizations to adopt/implement industry 4.0 technologies for economic, operational and environmental sustenance? and; (2) What are the attributes of sustainable green practices for increased outcomes in lean manufacturing processes?

2. Literature Review

The institutional theory of information technology supports the foundation of this study. As theory is related to stability and persistence, information technologies are connected with fast, and now and then troublesome cultural and organizational changes (Currie, 2011). Staggered learning approaches recommend that people, groups, and associations act both autonomously and interface dynamically to add to organizational performance (Gottman et al., 1998). It is recommended that public policies leaning towards the adoption of sustainable green practices will significantly affect the fortifying countries' economies. Moreover, the progression of an adaptable energy asset framework will make mindfulness among manufacturing companies and assist them with working on their substantial presentation (Yadav et al., 2020).

To investigate the micro and macro viewpoints of green innovation to adopt industry 4.0 parameters and eco-friendly production, the research would improve insightfulness to comprehend the primary determinants of the Technology Acceptance Model (TAM) a firms' and industry 4.0 point of view. The review proposed micro and macro initiatives as energy-augmented TAM models and found that microenterprise TAM is related to green investment that builds the utilization of environmental-friendly interests to further develop coordination and execution, technological advancement, innovation, resourcefulness, and competencies. These variables would to a great extent backing to green practices, which are filled by green R&D consumptions (Anser et al., 2020).

The Theory of Planned Behavior states that behavior can be anticipated or disclosed by the objective to do so. It means that the purpose to support the utilization of innovation is an impetus to make a move, settle on choices about the utilization and adoption of innovations later on. Accordingly, the basic aim to use the information system is the objective of the end-user to utilize the new innovations. A review on the use of TAM to the utilization of information technology has likewise applied TAM theory to utilize which shows a significant relationship between actual decision and the intention to use (Ajzen, 2011). A number of reviews intend to assist SMEs with being more mindful of the advantages, difficulties, and advancements with the rapidity of Industry 4.0, subsequently working on the viability of the adoption of Industry 4.0, accordingly helping business exercises accomplish better outcomes to add to the economy in the solid momentum growth (Nguyen & Luu, 2020).

It is important for firms to rehearse great IT expertise for keeping an undeniable degree of IT security standards. Also, Industry 4.0 calls for new skills and leadership concerns and the board responsibilities. The managerial willingness and endorsement for large interest in more up-to-date innovations are important to develop feasible infrastructure for Industry 4.0. Firms should not just focus on smart manufacturing but also on quality frameworks and customers for better outcomes in human resources development and change management to bring social sustainability (Bag et al., 2018).

The general advantages of environmental collaboration in green processes involve the presence of a profit-Pareto-efficiency region. In any case, the environmental perspective neglects to happen in the Pareto-efficiency, which shows the jumble among economic and environmental execution. In addition, a lump sum value agreement may assist with upgrading environmental performance while supply chains may lean toward a profit-sharing agreement or vertical coordinated chain to augment benefits (Liu & Giovanni, 2019).

There is a direct and indirect impact of the managerial interactions in organizational performance in order to carry out the strategic outcomes. The research outcomes show that there is a positive relationship of direct relationship and a relatively indirect relationship of the direct relationship with the other members of the organizations in order to carry out the different strategic objectives (Srimai et al., 2011). Aforesaid in view, there could be an increase in the set of sustainability (SUS) indicators by including the effect of the green supply chain on organization performance (OP), just as further investigating the association between quality, lean and green practices for economic and sustainable performance (Micheli et al., 2020).

Industry 4.0 is identified with value addition to the manufacturing process (Frank et al., 2019). Notwithstanding the continuous exploration on energy effectiveness and development with regards to Industry 4.0, little is known on what level of spillages in the economy can mean for the energy-innovation. This issue has been highlighted to the United Nations in their Sustainable Development Goals (SDG) report. In Industry 4.0 era, this issue can be important from per sustainable development point of view (Chen et al., 2021). According to business respondents, the execution of market innovations promoting Industry 4.0 is itself a competitive advantage contrasted with different organizations. This is an increment in underlying performance coming about because of innovation (Ungerma et al., 2018).

The production side of supply chain resilience is directly associated with organizational performance, supporting the proposed supply chain empirically and for appropriate strategy (Gölgeci & Kuivalainen, 2020). Accordingly, manufacturers benefit the suppliers who have satisfied the purchasers as per a high level of commitment for smooth business relations. It is clear to mention that growth among supply chain partners is directly proportional to mutual development, commitment, and interest. For example, the agri-food industry, where

transshipment of the fresh food and vegetables is made from rural to urban areas, especially for the business malls, foster their systems, green processes, innovations, and plans of action to oblige the attributes of metropolitan and peri-urban agricultural products, for example, low and dynamic supplies and FMCG consumers those are supporting the farmers through reasonable exchanges (Nakandala et al., 2020).

In the same way, suggestions of another food project discovered the alternatives. It has relied that the conglomerates would foster another proposition on food safety and yet one that additionally broadens its extension to incorporate food handling and food quality, nourishment, food loss and wastage, sustainability, and so forth that reinforces the vocational arena made accessible to proficient partners because of their closely associated requirements and assumptions.

At the point when innovation performance becomes essential for the corporate strategy of the companies, top management will be serious about innovation performance, which will eventually make the organization on track to newness through the trickle-down effect (Aslam et al., 2020). The effect of innovative performance on sustainability highlights the commitments of top management and other stakeholders in the supply chain networks to the organizational dominance in the market (Tuan, 2016).

It is challenging to measure organizational performance, especially when the measurable components keep on changing. However, the concept of sustainability has radically explored the scope of measurement, and market leaders are particularly in problem what must be figured out continues to change. The idea of sustainability has significantly extended the extent of measurement choices and driving forces are grappling with sustainable mapping, however, there is no indication of consensus. It has been revealed these reporting standards are indescribably confounding (Hubbard, 2009).

How the Chinese manufacturing industry was improved by adopting lean operations in the industry. It has been observed that lean operation has a positive influence on industrial performance in operations. In this research human resources, supply chain, and production system design were studied in three dimensions of flexibility, flow, and quality. It was concluded that the design of the product has a significant impact on the performance of the engineers and technicians. The more the design is flexible, the more quickly will be the restoration of the desire of the customer. Designing and quality enhanced the performance of the employees working on technical sites.

There is a need to carry out the functionality test and evaluation of the structures to obtain the best practices in the system. The discussion how the companies performing the production and operations, are lean or agile. Basically, a lean manufacturing system coordinates the customer-oriented production system in which the user's desire can be nourished up

to a limit. Alternatively, the companies following the agile techniques are not flexible for the said opportunity. It indicates that the development of relationships with customers enhances product sales turnover and customer loyalty. For this purpose, the nurturing of managers is important who are directly dealing with the customers in the market (Netland & Alfnes, 2011).

Innovation performance is a never-ending process and the companies have to strive to accomplish it for achieving the feasible cost and profit, as well as increased customer goodwill and satisfaction, in order to enhance the forthcoming business. Therefore, the most appropriate mode of estimating and redesigning is the manufacturing measures performance that should be monitored and the execution plans evaluated on regular basis (Parthiban & Goh, 2011).

In business today, the development of Industry 4.0 for optimized production, and its associated advancements, like the Internet of Things (IoT) and cyber-physical frameworks, among others, have, nevertheless, an adverse consequence on sustainability in terms of environment is because of air pollution, improper release of waste, and utilization of unrefined substances of raw material, data information, and energy. Sustainable green practices in manufacturing organizations drive the development of new products and services, strategies, and innovations that empower financial outcomes and prosperity of organizations while considering the natural resources, and regenerative limit (Calik & Bardudeen, 2016).

Business enterprises could be supported in developing economies by integrating capabilities to combine available resources in order to enter into the diversified markets rapidly and cost-effectively (Gurtoo, 2009). The author has discussed that a few reforms are needed to be addressed in a particular context as the economy is getting down for the last few years. In public sector organizations, the members should develop a mutual consensus for the subsequent accomplishment of the green objectives.

Keeping in view the fact and theoretical nature of Industry 4.0 in terms of implications and management, empirical research is recommended for study in which implementation of digitalization is accompanied by a conducive environment with the interaction of men and machine while considering the legalities, obligations, assurance and ethics (Tjahjono et al., 2017). The advent of the fourth industrial revolution, referred to as industry 4.0 and its applications in the manufacturing companies have guided another era for business organizations. It assures the upgrade in operational efficiency and effectiveness as well as amplifies the economic performance (Sharma et al., 2021). The implication of digitalization has a positive impact on environmental and economic performance. In terms of Industry 4.0, advanced digital technologies, including cloud computing, Internet of Things (IoT), big data analytics have emerged drastically (Li et al., 2020). Moreover, business innovation models, through the adoption of industry 4.0 (I4A), address both the challenges and opportunities for business entities (Müller & Däschle, 2018).

H1: Adoption of Industry 4.0 has a significant impact on Green Practices.

The innovation performance (IP) strategies determine the innovation management in a very easy, simple, pragmatic, and implementable way while handling the limitations of former frameworks of innovations. In absolute innovation management, the firm will embrace the innovation performance strategies that will subsequently develop the innovations as part of routine work in organizations in contrast to considering it as a standalone activity that should be overseen independently (Aslam et al., 2020). Green innovation is a mandatory part of acquiring a competitive advantage in sustainable supply chains to accomplish sustainability objectives. Notwithstanding, supporting SUS and GP development in supply chains through green innovations is a complicated network activity in which stakeholders are involved, and the need exists to share the information in an equivalent and sensible trade process (Zhou et al., 2020).

H2: Innovation Performance has a significant impact on Sustainability

The GP has been regarded as a sustainable business drive by the researchers. Moreover, the relationship among supply chain partners has a great impact on GP (Yang & Lin, 2020). A fair and reasonable distribution of power among farmers, retailers and consumers will permit reasonable economic returns to producers and fortify the social relationship with native end-users (Nakandala et al., 2020).

H3: Green Practices has a significant impact on Organizational Performance

Sustainability (SUS) problems have been investigated in various ways and settings. While discussing in terms of economic, social and environmental perspective, impacts of present and anticipated climate change and reasonable efforts towards sustainable production and consumption of low-fossil carbon energy framework are addressed and applied (Tseng et al., 2013) In this industrialization era, ecologists are worried about the climatic changes and consistently keen on finding out the reasons that can work with the progress towards sustainability for substantial OP (Ahmed et al., 2020).

H4: Sustainability has a significant impact on Organizational Performance.

Industry 4.0 (I4A) could have an empowering influence on feasible business plans of action, however, it can likewise be an inhibitor by further taking advantage of the potential outcomes of neo-classical business models (Man & Strandhagen, 2017).

H5: Adoption of Industry 4.0 has a significant impact on Sustainability

Organizations with developed R&D departments, collaboration with different stakeholders including competitors is a suitable way of further developing IP, particularly in eco-friendly areas. Unexpectedly, the coordinated effort likewise assists SMEs with minimal financial and informational resources in order to get new skills and competencies to change the technologies with alternatives, the plan of action or both, and foster green IP advancements more effectively and with lower costs (Calza et al., 2017)

H6: Innovation Performance has a significant impact on Green Practices

Nexus to the context, business consensus can be developed by inculcating the technological realization among the supply chain organizations. More the wastes are reduced, the production will become more profitable. Conclusively, there is a need to introduce the digitalization concepts through innovation performance and smart industrial revolution like acquiring the solutions to handle the seven production wastes.

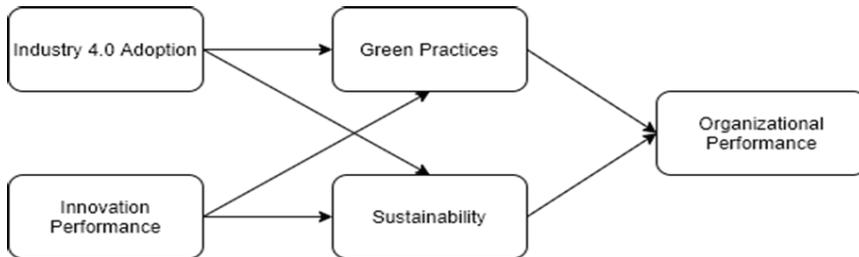


Figure 1: Organizational Performance chart

3. Methodology

This is a descriptive study. The questionnaire was adapted from various resources mentioned in Table 1. Moreover, for content validity, the questionnaire was consulted with the experts of academia as well as practitioners and found appropriate.

3.1 Sampling Technique

The study has been carried out by floating the questionnaire to the respondents pertaining to the top, middle & lower management of different supply chain and logistics organizations from major cities of Pakistan i.e. Islamabad, Rawalpindi, Lahore, Faisalabad, Karachi and Multan. These were suppliers, manufacturers, whole-sellers, distributors, and retailers. It has been a good experience while consulting with stakeholders.

3.2 *Instrument Adaptation*

As the questionnaire was adopted, therefore, expert consultation was taken from 05 experts from academia as well as 05 senior practitioners performing their responsibilities in different organizations. During this process, the instrument was tested under the expert visionary analysis of the scholars as well as practitioners.

Table 1:
Instrument Source

Variables	Items	Source
Industry 4.0 Adoption	6	Chauhan et al. (2021)
Innovation Performance	7	Hussain et al. (2018)
Green Practices	4	Yacob et al. (2019)
Sustainability	4	Hussain et al. (2018)
Organizational Performance	3	Zhu et al. (2012)
	2	Hussain et al. (2018)

3.3 *Validity and Reliability*

The estimated Cronbach alpha for Green Practices is 0.750, Industry 4.0 Adoption (I4A) is 0.851, Innovation Performance is 0.888, Sustainability is 0.762 and Organizational Performance is 0.925. In the light of the results, it can be concluded that all the results are above the acceptance level (0.60 or 0.70), so all the items are internally consistent.

3.4 *Sample Adequacy*

The questionnaire was distributed to 27 Supply Chain and Logistics organizations. After the pilot testing, the results of all dimensions were found appropriate. The Cronbach's alpha values are 0.750 for Green Practices, 0.851 for Industry 4.0 Adoption (I4A), 0.888 for Innovation Performance, 0.762 for Sustainability, and 0.925 for Organizational Performance which shows the sample reliability and adequacy. About 500 questionnaires were floated both online and in hard copies. However, only 297 responses were received, so the response rate is 59.40%. The questionnaire was distributed to the directors, deputy directors, senior managers, middle managers, and executives of manufacturing organizations including textile, plastic, leather, pharmaceutical, and FMCG. The respondents were male and female members of the organizations. The age group was formed in three categories of 'less than 25 years', '26 to 35' and '35 & above'. Qualification of the respondents was minimum intermediate and maximum PhD along with minimum job experience of two (02) years. The questionnaire data were obtained from the employees working in organizations situated in Karachi, Lahore, Faisalabad, Multan, Rawalpindi, and Islamabad.

4. Data Analysis

The descriptive analysis was carried out with respect to the induction of “Green Practices and Sustainability” as mediators. It has been observed that GP has a significant impact on OP, I4A has a significant impact on GP, I4A has a significant impact on SUS, IP has a significant impact on SUS, GP has a significant impact on OP, SUS has a significant impact on OP and I4A has a significant impact on GP. However, the results have shown that IP remained insignificant upon GP which means that Innovation Performance does not enhance the Green Practices. After the collection of data through questionnaires both floated online as well as by hand / hard copies, Smart-PLS has been used for data analysis.

4.1 Measurement of Model

4.1.1 Reliability testing

Reliability can be referred to as consistency. The reliability has been measured while using the composite reliability. It provides a better measure of internal consistency, besides Cronbach’s alpha (Hair et al., 2014). The composite reliability (CR) value for all latent variables is shown in Table 3. It is good to express that the CR value of the variables is found >0.7 (Hair et al., 2011).

Table 2:
Reliability Testing and Convergent Validity

Construct	Cronbach's Alpha	rho_A	P values	CR	AVE
Green Practices	0.750	0.759	0.000	0.841	0.570
Industry 4.0 Adoption	0.851	0.887	0.001	0.888	0.569
Innovation Performance	0.888	0.905	0.005	0.912	0.601
Organizational Performance	0.925	0.924	0.081	0.946	0.779
Sustainability	0.762	0.775	0.003	0.847	0.580

4.1.2 Convergent validity

As indicated by Hair et al. (2011), for convergent validity measurement, the AVE method is used. Also, its limit ought to be 0.5 or more prominent, and variable loadings ought to be above 0.70 (Hair et al., 2014). In Table 2 the qualities AVE are higher than 0.5. It likewise shows the loadings of variables as most of the values are above 0.7 with the exception of two loadings in GP and IP. Notwithstanding, most of the loadings are more noteworthy than 0.7 and AVE has been tracked down acceptable while certain items from all factors were eliminated.

4.1.3 Discriminant validity

Table 3 shows the correlation matrix, which affirms the discriminant validity. One more way to deal with affirms discriminant validity is actually taking a look at the cross-loadings of items. The cross-loading of every item in its own construct ought to be more prominent than cross-loadings on other constructs (Hair et al., 2011; Hair et al., 2014). As indicated by Gefen and Straub (2005) and displayed in Table 4, there ought to be a distinction of 0.1 between the cross-loadings on its individual construct and loadings on other constructs.

Table 3:
Discriminant Validity

	GP	I4A	IP	OP	SUS
GP	0.755				
I4A	0.388	0.754			
IP	0.360	0.746	0.775		
OP	0.390	0.616	0.718	0.883	
SUS	0.355	0.450	0.450	0.445	0.762

4.2 Inner model measurement and hypotheses testing

When the outer model estimation is assessed, the data is examined for the inner model estimation (Henseler et al., 2009; Hair et al., 2011). The Partial Least Square (PLS) is utilized to test the theories by utilizing bootstrapping (Haenlein & Kaplan, 2004). A bigger number of sub-example (normally at least 5000) are drawn from the first information utilizing this resampling strategy (Hair et al., 2014). According to the results in Table 2, all AVE values are as per the threshold standard. Similarly, CR values of all variables are above 0.6 which validates the acceptance range. Cronbach's Alpha values being coefficient of normality have also been observed up to the mark i.e. 0.70.

In contrast to Cronbach's alpha, CR value doesn't expect that all indicator loadings are equivalent in the populace, which is in accordance with the functioning standard of the PLS-SEM calculation that focuses on the indicators dependent on their respective reliabilities during the model assessment. Besides, Cronbach's alpha is additionally touchy to the item numbers in the scale and for the most part, will, in general, belittle internal consistenc reliability. By applying CR, PLS-SEM can oblige diverse indicator reliabilities (Hair et al., 2014).

Table 4:
Outer Loadings

	Green Practices	Industry 4.0 Adoption	Innovation Performance	Organizational Performance	Sustainability
GP1	0.741				
GP2	0.779				
GP3	0.788				
GP4	0.710				
I4.01		0.826			
I4.02		0.740			
I4.03		0.708			
I4.04		0.784			
I4.05		0.716			
I4.06		0.746			
IP1			0.889		
IP2			0.723		
IP3			0.757		
IP4			0.866		
IP5			0.763		
IP6			0.658		
IP7			0.744		
OP1				0.687	
OP2				0.914	
OP3				0.931	
OP4				0.917	
OP5				0.939	
SUS1					0.688
SUS2					0.782
SUS3					0.799
SUS4					0.774

According to Hair et al. (2014), Table 3 represents the discriminant validity of all variables is well adjusted which indicates the extent that empirically, every construct is different from other constructs or, in other words, the measure of the construct that is intended to measure. Table 4 values show the appropriate values of convergent validity that confirm the outer loadings of each item is above 0.70 when the average variance extracted (AVE) of each construct is 0.50 or higher (Hair et al., 2014) except IP6, OP1, and SUS1. However, values above 0.60 are also somehow acceptable.

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4.2.1 Hypotheses testing

According to the results shown in Tables 5 & 6, there is a need to transform the manufacturing companies into smart factories. Moreover, the purpose of this transformation is to get the benefits of green supply chain management. The study investigates the impacts of two dimensions of I4A and IP on social, economic, financial, and operational, from both a contingency and a configuration perspective.

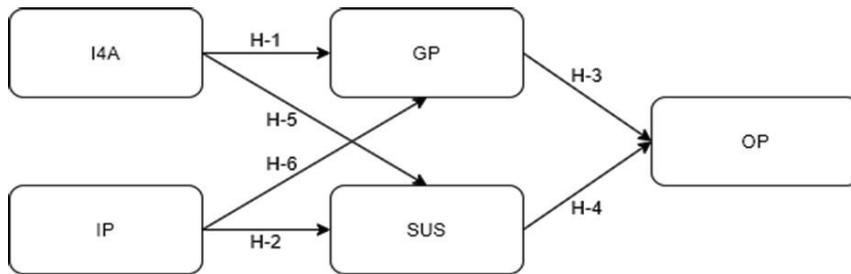


Figure 2: Hypotheses testing

According to the contingency viewpoint, we applied SEM to calculate the effects of individual factor dimensions and their interactions on organizational performance. According to the configuration viewpoint, we applied cluster analysis to foster examples of I4A and IP with the mediation of DP & SUS, which were analyzed in terms of OP perspective. The data was collected from SCM and logistics-related manufacturing companies to test the hypotheses. The results from both the contingency and configuration perspective show significance validation which was related to overall organizational performance.

Table 5:
Path Coefficients

	Original Sample (O)	Sample Mean (M)	St Dev (STDEV)	T Stats (O/STDEV)	P Values	Results
GP -> OP	0.266	0.266	0.062	4.320	0.000	Supported
I4A -> GP	0.269	0.270	0.084	3.215	0.001	Supported
I4A -> SUS	0.259	0.260	0.091	2.833	0.005	Supported
IP -> GP	0.159	0.164	0.091	1.745	0.081	Not Supported
IP -> SUS	0.257	0.262	0.085	3.007	0.003	Supported
SUS -> OP	0.351	0.355	0.049	7.143	0.000	Supported

In this research study, there are six (06) hypotheses. These have been examined through structural equation modeling (SEM). The results of the tested hypotheses have been shown in Table 5 (Fig. ‘C’). The results of Hypothesis ‘1 to 5’ are in accordance with the previous research (Chauhan et al., 2021; Hussain et al., 2018; Zhu et al., 2007). However, some have not been revalidated for Hypothesis 6.

Table 6:
Quality Criteria

	R Square	R Square Adjusted
Green Practices	0.162	0.156
Organizational Performance	0.260	0.255
Sustainability	0.232	0.227

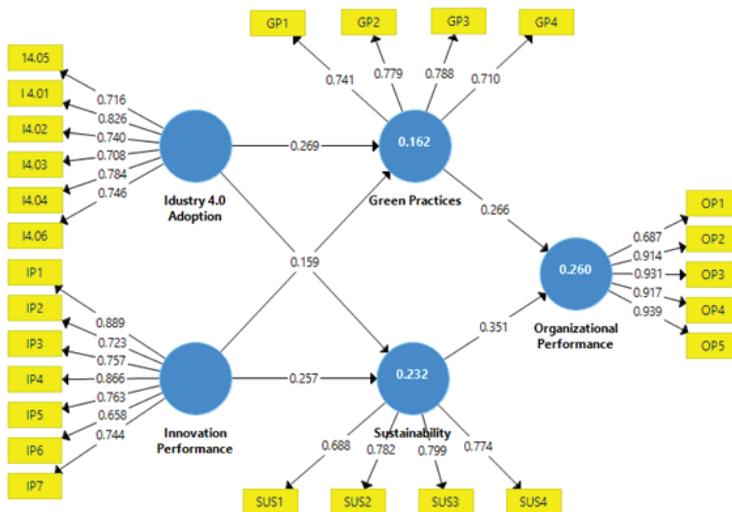


Figure 3: Organization Performance Research Model

The IP is not a significant predictor of GP which shows that results are not in accordance with the previous studies (Ahmed et al., 2018; Cousins et al., 2019; Li et al., 2021; Lin et al., 2014; Luu, 2020; Perez-Valls et al., 2016; Yacob et al., 2019; Yu & Ramanathan, 2015). However, revalidation of previous studies has revealed that IP has a significant relationship with the GP and OP (Luu, 2020). Moreover, the relationship of GP with OP is found consistent with previous literature (Ahmed et al., 2018; De Giovanni & Cariola, 2021).

5. Discussions and Conclusion

As per the viewpoint of DiMaggio and Powell (1983), Institutional Theory drives the reason to the systematic analysis of innovation, utilizing various aspects of theories about the formal and casual establishment of relationships, just as the various levels of organizations (Geels, 2010). Besides, the Principle of Continuous Creation says that business as an organization is a value creation institution, therefore, the theory is required for a discipline to develop (Defee et al., 2010). Consequently, the I4A (Adoption of industry 4.0) idea in business becomes most significant and adaptable. While the institutional theory is discussing persistence and stability, digitalization concepts are connected with rapid, and some of the time problematic, societal and organizational changes.

Reliability means that the organizations are conforming to the realization for the adoption of I4A as a mandatory requirement. These elements including IP, GP, and SUS have both financial and non-financial impacts upon the performance of the organizations. In order to respond and comply with external pressures to adopt green supply chain management, focal firms have to collaborate with smart process activities and monitor the thresholds to further back up the supply chain to achieve the wholesome effect (Ahmed et al., 2020). The author has investigated various scientific theories in the study. It is concluded that lack of technological competencies and lack of willingness towards implementation of process innovation are the major obstacles to the adoption (Ahmed et al., 2018; Li et al., 2021; Luu, 2020; Yacob et al., 2019; Yu & Ramanathan, 2015).

According to the author, I4A has an influential role in the progression of business in a sustainable manner because when a company moves to strengthen its supply chain, hence, I4A is the one in which the business can grow at the optimal level. Industry 4.0 has a greater scope of responsibility in the automotive industry sector for its application and adoption as compared to other sectors. Same has been endorsed empirically that innovation performance and market ideas when applied through industry 4.0 make the enterprises more competitive (Ungerma et al., 2018).

A comprehensive study is discussed based on the literature that elaborates the importance and challenges of I4A with respect to SUS in four different perspectives: operations and technologies, implementation, integration, and compliance with respect to organizational long-run objectives. The results of the study posed both positive and negative dimensions of inflows and outflows with brief explanations of raw material, information and energy consumption and disposal of product and waste respectively, with a predominance of positive influences as derived from I4A (Bonilla et al., 2018). There is no evidence about the presence of an applied SCM that defines the theoretical constructs and role of I4A. However, conclusive findings have revealed that I4A has an effect on digital supply chains, driving the proposition for a reasonable model which addresses the flaws of prevailing interconnectivity between various components in order to curb the seven wastes. The purpose of our review was to investigate the effectiveness of SUS in supply chains (i.e., collaboration and assessment). In this regard, the impact of I4A has been tested with respect to buyer and seller social performance. The results have suggested that collaboration enhances the sellers' social performance whereas buyers' social reputation is the advent of buyers' social reputation (Sancha et al., 2016). The same has been revalidated in this study.

Results have become more interesting with the inclusion of GP and SUS as mediating variables. The results suggest that there is a strong relationship between I4A and OP in the presence of GP and SUS as mediating variables. Conclusively, the results show that the model is significant. It is commented that corporate decision-makers should equip certain digital parameters to the companies to produce innovative products for the customers. This is a comprehensive overview of the sustainable supply chain partners how they perform the transactions with green practices. Moreover, it has also been studied that a greater number of products used require sustainable aspects. However, some areas are not sustainable as they are neglected and there is a variation in the regions overall as well as the nature of the products. The sustenance can be achieved by effective communication among the manufacturers. Further, sustainability as a relationship may contribute internationally to a good flow of products in the global market.

In this study, I4A and its impacts on GP, SUS, and OP have been studied how these can be strengthened through IP and SUS. Moreover, how green digitalization has a significant impact on the overall performance of firms, so in the light of this result, it can be argued that I4A is one of the important elements of study. For the reliability of the questionnaire, a test run and the results of Cronbach's Alpha are more than 0.70 which indicates that there are no issues with reliability. Unfolding the results' argument, leading manufacturers in developed countries have already adopted the implementation of I4A and have high levels of awareness. However, it is uncertain how such practices are implemented (Scur & Barbosa, 2017).

Nexus to the above results we can narrate that organizations should take all necessary action for the industrial revolution, green innovations, and sustainable developments among the manufacturers because said characteristics have a significant positive impact on economic, operational, and environmental performance. Thus, there will be an enhancement in production and waste reduction which will ultimately result in efficient outputs. The results have revealed that a moderate level of positive resorptive capacity inappropriateness is the best option for companies to upgrade their supply chain networks' convergence (Roldán Bravo et al., 2020).

5.1 Implications

This research study has the following implications which can benefit suppliers, this research study has the following implications which can benefit suppliers, manufacturers, purchasers, and academic institutions.

5.1.1 Academic Implications

Institutions are the producers of efficient engineers, technicians, managers, entrepreneurs, and professionals who apply management theories for the resolution of business problems. When academia trains these participants or stakeholders of organizations professionally and innovative manner, the academic constraints of industry 4.0 and sustainable green practices play a pivotal role in producing quality scholars for the society which subsequently increase the goodwill of the respective institution. The effect of adoption of digitalized industrial adoption is an important area of research within studies of business organizations for efficient production levels. In the case of academia, these are terms as the smart factories of efficient professionals to the organizations who are the end-users as qualified producers. Moreover, academia is proposed to focus on digitalization for the upcoming industry 5.0 arena and encourage the research environment to mitigate the problems of supply chain stakeholders. This approach will lead academia into socially benefitted organizations.

5.1.2 Managerial Implications

The concept of smart manufacturing is associated with implications of I4A. Managers learn more in a conducive and innovative environment. The study revealed that a smart manufacturing environment favors the managers to produce better and control losses. During data collection, managers indicated that adoption of industry 4.0 drives the fulfillment of organization objectives exclusively when designed for the purpose. This evidence infers the reason why a lack of empirical studies failed to support the impact of innovation performance on green practices. Most of the respondents pointed out the economic perspective as a precursor of I40 implementation. Conclusively, I4A is productive when aligned with organizational objectives. Secondly, managers should analyze the return on investment factor of I4A.

Thirdly, the company's strategic position in the market should be considered in long run and both explorations and exploitations should be focused on to get optimal benefit.

Innovative interests and technological determination in I4.0 should be co-planned with the manufacturing companies. Managers, in some cases, perceive that, when the innovation is there, they will figure out how to make it work, yet these experimental outcomes obviously show that this isn't true. Then again, given the novelty of I4.0 adoption, it might take excessively yearn for an organization to truly set itself up to make the investments. Thusly, technological investment and changes in the companies should be co-created, while utilizing solid support and contribution from the functioning jobs.

A subsequent point is that organizations ought to appropriately assess the development of their association, with explicit consideration paid to organizational structure, professionalism and abilities. Running an appropriate authoritative appraisal, other than being helpful speculation, is basic for assessing people's genuine capacities to manage new methodologies, just as the degree of venture needed to fill skilled holes.

Lastly, organizations ought to consider making a coordination job inside the companies to outline all socio-specialized advancement projects – ensuring appropriate arrangement among the diverse authoritative units that are rational with organization technique.

5.2 *Limitations of the Study*

The limitations of this study must be accredited. Firstly, data was gathered from 297 respondents whereas primary data is always subject to biaseness up to some extent. Secondly, limited numbers of supply chain companies including textile, leather, FMCG, and plastic (only 19) were incorporated in this study; however future researchers can extend the generalization of the study to other sectors. Thirdly, time constraint was a major issue. The response rate was about 29.70%.

5.3 *Conclusions & Recommendations*

The research study has identified various factors to address the business solutions and has typically been focused on the identification of technological enhancement tools for the betterment of process and production in supply chain organizations through an analytical assessment of sustainability in the presence of green practices and digitalized platforms.

Implementing I4A can help to materialize the demand through appropriate determination and smart manufacturing. I4A refines data information, automates manufacturing processes, and transforms the inputs to profitable outcomes. For sustainable developments, manufacturing companies are recommended I4A and digitalized innovations to improve their

operational, environmental, and economic performance. It ought to be perceived that operational activities in the current business environment are profoundly information-intensive. Firms that get exact and concurrent information would thus be able to have prevalence in the competitive markets. I4A is essential for collecting and handling data information as well as production framework, conclusively supporting decision-makers adequately and proficiently.

For optimal economic, operational and environmental performance, organizations will have to adopt digitally-enabled technologies and infrastructure. In this research, we investigate the value creation of I4A and advancements in adaptable manufacturing under a sustainable and green perspective. I4A is an effective solution that Western manufacturing companies take on to confront rivalries from low-cost producers. Organizations taking on I4A use smart concepts and digital technologies to transform manufacturing processes automated and more adaptable. Conclusively, it is evident that I4A drives towards higher usefulness and better production outcomes, further developing the economic portray of organizations much presentable in the production index.

5.4 Future Research

For future directions, in addition to the proposed research model, there should be the identification of barriers (challenges) that resist the organizations to implement industry 4.0 technologies for economic, social, and environmental sustenance. Secondly, a feasible way out for handling the seven wastes (overproduction, inventory, motion, defects, over-processing, waiting, and transport) in lean production through digitalization is recommended. Lastly, appropriate parameters for the enhancement of capacity building of potential manpower are realized for further exploration through implications of circular economy in a sustainable environment.

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