

Mediating Variables in the Path of Human Capital and Digitalization



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Abstract: *The industrial structure of a country has an essential role in determining its competitiveness, growth, and sustainability. Many countries are experiencing significant industrial upgradation and transformation and emerged as gigantic players in global trade. It is vital to understand the factors contributing in the upgradation and transformation of the industrial structure of Pakistan as well as other Asian countries because it is hardly intensive on in the literature. Study incorporate 30 Asian countries from the time period 1995 to 2022. This study explores the potential factors like labor quality and digitalization on the upgradation and transformation of industrial structure. Multiple econometric techniques like regression and Hausman test are applied for a comprehensive analysis of data. It is hypothesized that mediating variables has a positive contribution in upgradation and transformation of the industrial structure. Moreover, digitalization upgrades and transforms the industrial structure by improving connectivity through different mediating variables. Study include three mediating variables 1) institutional quality 2) unemployment 3) Research and development. Based on the study findings, these countries should prioritize investments in education and skills development to enhance human capital quality. Findings also suggest policies that helpful in the development of digital infrastructure and the creation of job opportunities. In this way, these countries can accelerate the upgradation of their industrial structure, leading to sustainable economic growth, increased competitiveness, and improved living standards. In conclusion, relationship of labor quality, digitalization, and industrial structure provides valuable visions into enhancing productivity, promoting economic growth, managing employment dynamics, fostering innovation, and driving sustainable development. Institutional quality and research and development has a positive impact on digitalization whereas unemployment rise due to digitalization. Such research is essential for policymakers, businesses, and individuals to navigate the evolving industrial landscape effectively.*

Keywords: Upgradation, High Quality Labor, Mediating Variables, Digitalization, Human Capital

1. Introduction

It is staple of great concern that how developing economies can upgrade and transform industrial structure (Rodrick, 2016). Only a few countries improved their per capita income despite many attempts to increase their income through structural transformation (Wade, 2016) Many

developing countries set lofty targets for the quality of the labor force, digitization, and its favorable effects on upgrading structural transformation. It is yet unknown which factors may affect the process of upgradation and transformation of industrial structure (Friederici et al., 2017) because the effects of labor quality

and digitalization are rarely supported by empirical evidences (Kunel et al., 2020) The term upgradation of industrial structure “is a process of improving or advancing existing industrial infrastructure within a given sector or region” (Krugman, 1994). It involves modernizing and enhancing various aspects of industrial operations, such as technology, processes, equipment, and overall efficiency, to drive economic growth and competitiveness (Sen, 2014). The upgradation of industrial structures can encompass many dimensions, including technological advancement, infrastructure development, skills development and research and development (Sen, 2018).

World is going to change at every next moment according to different circumstances such as environment, technology and situation etc. all these changes influence the human capital so they need to change according to the above circumstances. In this regard, only modern technology (digitalization) is the source that facilitate them to move towards modern changes. Advancement goes away from the organizational and defensive boundaries, comprising agility, intelligence, and networking force. With the Industrial Revolution there is need to change human behavior towards the technology. Successful and sustainable upgradation efforts are helpful for industries to stay competitive in a rapidly changing economic landscape (Ferrearini et al., 2021).

Technological change plays a vital role for development and growth. It is perceived in economic thinking that long run growth sustainability is due to technological progress in the economies. Solow (1957) highlighted this phenomenon in his growth theory proving that 80 % economic growth is explained by technical progress in USA during the first five decades of the 20th century. Technological change is a dynamic process that affects the patterns of job creation in labor market and also transforms the existing patterns of employment. These changes have critical implications for labor class, employers and cities (Gonçalves, et. al. 2021). There are optimistic and pessimistic views explaining level and extent of technological change with reference to economic and social

debates. The artificial intelligence and automation created the concern for job polarization. It is evident that middle-skilled jobs are depleting along with middle income jobs. It will worsen the problems of income inequality. The fourth industrial revolution will change the occupational patterns and it will be a threat not only for developing economies but for developed economies also (Surbakti, et. al., 2020). The trends of structural changes in developed countries are characterized by “hollowing out” of middle classes.

Adoption of digital technology and globalization plays a vital role in the today’s world. Emission reduce, new job opportunities are created by the use of digital technology. To our best knowledge, this study has not been covered in pervious literature till today. All these done due to the effort of human being or human capital. In unique terms, human capital is defined as the knowledge, skills and health that a person invests to earn money or to build their potential as productive member of the world. The human capital grows almost by 11.7% over the long term. The digital transformation of human capital made the traditional human resource management into the latest one. Companies are hiring the labor who knows to use modern technology for the purpose of digitalization. Now a days, without digitalization a company cannot made rapid growth. In last ten years, Asia growing rapidly in infrastructure and technological capabilities that help in human development. Range of sectors expanding such as banking health care, manufacturing, electronic commerce and retail. (Roy,2022). According to Aqib and Zaman (2023), Green development is affected by the effort of Human capital but also become cause to change in labor market as well. Significantly, there is increase in demand for human capital and it is need of time to transform human model into human capital dividend model.

In this modern era, study of digitalization directly linked with industries. The impact of digitalization and human capital remains a critical area of research, especially in case of Pakistan and Asian countries. Despite the recognized significance of these factors, there is

a lack of comprehensive understanding regarding their interplay and the implications for industrial development. Therefore, this study aims to investigate the specific affecting mechanism variables through human capital and digitalization in Pakistan and in other Asian countries. Moreover, it will be a significant addition in literature to find the synergies and interdependencies between labor quality and digitalization in facilitating industrial upgradation and transformation. This study aims to contribute to the existing knowledge base and provide actionable insights for policymakers, industry leaders, and stakeholders involved in industrial development and transformation.

In today's world, without digitalization and effort of human capital an economy is just like a barren land that need to fertile for productivity. Digital economy has impact on technology while other have impact on wages, inflation, labor market and production. (Ahmad, 2023). Use of digital technology not only improve the industrial sector but boost resource efficiency, reduce emission and create a lot of new opportunities in the economy. Technological innovation is working as an essential engine for economic growth and human advancement.

To govern the impact of labor quality and digitalization on industrial upgradation and transformation has much significance for several reasons. It is vivid that labor quality and digitalization are crucial factors in driving economic growth and industrial development. Understanding how these factors interact and influence each other can provide valuable insights into strategies for promoting sustainable economic growth. Moreover, labor quality refers to the knowledge, skills, and capabilities of the workforce. By studying the impact of labor quality on industrial upgradation, we can identify ways to enhance productivity. Improved labor quality through training, education, and skill development programs can lead to increased efficiency, better use of technology, and higher output. In addition, digitalization, including the adoption of advanced technologies and automation, plays a pivotal role in industrial upgradation and transformation. Analyzing the

interplay between digitalization and labor quality can shed light on the necessary skills and competencies required to effectively utilize digital technologies and leverage them for industrial advancement. High labor quality and effective digitalization strategies are key drivers of industrial competitiveness and innovation. Researching the impact of these factors on industrial upgradation can help countries and industries identify areas for improvement, develop targeted policies, and foster innovation ecosystems that facilitate technological advancements. In conclusion, relationship of labor quality, digitalization, and industrial structure provides valuable insights into enhancing productivity, promoting economic growth, managing employment dynamics, fostering innovation, and driving sustainable development. Such research is essential for policymakers, businesses, and individuals to navigate the evolving industrial landscape effectively.

Based on pervious literature, after introduction study will be forward in the following order: Section 2 consist of related literature whereas section 3 consists of model building and section 4 analyzes the descriptive and empirical results and section 5 of conclusion and some policies recommendation.

2.Literature review and research hypothesis

2.1 Literature review

2.1.1 Digital economy concepts and its application

Annual reports on the digital economy were start to publishing since 1998 in U.S. Its evaluation has created global attention and frequent academics have made careers out of researching it. According to Ozkan and Ozen (2020) digital economy has advantages of cost reduction, global value and service inserting. In the other words, information technology is considered as the backbone of the industrial development and human capital plays a vital role to improve the information technology through digitalization.

The presences of internet platforms has gradually provide benefit to products or consumers to bring market structure closer and

made innovation as well. Moreover, digital economy has also an application of improvement in market mechanisms, enhancement of economic performances and high quality development. Technological change plays a vital role for development and growth. It is perceived in economic thinking that long run growth sustainability is due to technological progress in the economies.

2.1.2 Literature related to the digital economy

According to the Romer's model, technological change driven by the invention of new products as a result of R & D. Solow (1956) explained in his economic growth model that technological progress is exogenous. Zhang et al. (2022) utilize subscriptions such as mobile phone, fixed broadband, fixed telephone, individual using the facility of internet to construct digital economy on the economic growth. The outcomes illustrate that how essential technological innovations are for promoting sustainable development. Different theoretical models have shown the effects of technology adoption on economic growth and found no agreement on the findings.

Role of globalization and technology has a positive impact on the transfer and their spillover effects. Role of ICT is also important in promoting the innovation and rising revenues.

Li et al., (2015) highlighted that China manufacturing sector analysis of the labor intensiveness for the low-end labor market. When empirical studies focus on manufacturing-intensive industries and work on upgrading and transforming the labor market. In the labor market, wages and quantity of labor are based on the labor market. Results suggest that for the development of employment quality and quantity and to enhance the sustainable labor market development is possible through the transforming and upgrading of labor-intensive manufacturing. Kaunas et al., (2019) identifies the digital transformation and Industry 4.0 on the Small and Medium Enterprises (SMEs) in Pakistan. A questionnaire was developed to collect the data from the randomly selected countries in which Karachi, Lahore, Peshawar, Sialkot, and Gujrat are included. By using SPSS,

multiple regression techniques are applied for insight into a future framework and this study helps the manager to identify the allocation of resources towards the development operation of the firms. In the end, it will help policymakers to devise the appropriate strategies to develop human capital and increase their absorptive capacity.

Frank (2019) stated that Industrial Revolution 4.0 has been considered as a new stage for the world to cover the digital problems but the main deficiency observed by this paper is the need for understanding of how companies incorporate technologies. Results show that big data and analytics are low implemented and base technology are high in companies. Eleyyan et al., (2021) explicated with their study that modern efforts are aiming towards raising societal awareness as regards education by the 4th Industrial Revolution IR 4.0. The study used four products to expose the effects that are Internet of Things, big data, cyber security, artificial intelligence, cloud computing, Blockchain, and robots on the educational variables control learning, learning opportunities, Instructional activities, and social implications. The study also highlighted those four products showed significant transformation in education with Industrial Revolution 4.0. J. Liu et al., (2020) examined the structural change of multiple structure through general equilibrium model.

Bag and Preterious (2022) described on the basis of the theory that digital economy enhance the transformations and upgradation in industrial sector and studies the theoretical mechanism that effect in such a way for example cost-saving, scale operation, production efficiency growth and technological innovation empowerment. Forman & Van Zeebroeck (2019) stated that the basic internet access on knowledge flow towards the growth of digitalization. Almost majority of the theoretical models have progressive effects in technology adoption and globalization. Furthermore, few studies were conducted to analysis the influences the technology. Many indicators effect the digitalization and human capital but few of them are most important such as

institutional quality, unemployment and research and development.

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2.1.3 Research hypothesis

According to the above literature, Study concluded the two hypotheses to attain the objective.

Hypothesis 1. The digital economy contributes positively on human capital through mediating variable.

Hypothesis 2. The digital economy does not contribute positively on human capital through mediating variable.

From this literature it can be found that studies just only discuss the role of digital economy regarding to industrial sector. There is lack of literature on the importance of human capital and its mediating variables that effect the digitalization. Mostly studies just only highlighted the concepts of digital economy and does not incorporate the importance, role and analyses of human capital. Studies were also not trying to find out the mediating variables.

3. Data and Methodology

The general theory of industrial upgradation and human capital defines that the rhythm of

industrial upgrading is determined by the quality of human capital (Georgoadis ,2020) When it comes to attracting in foreign investment and encouraging the adoption of new technologies, human capital quality is crucial. As a outcome, the following theoretical claim has to be verified: The industrial structure is determined by human capital. The "digital economy" in the broader sense “integrates all digitally oriented economic activities, using the digitization of ICT as a key production factor, using contemporary information and communication infrastructure as a carrier, and offering goods or services with digital components. After the agricultural and industrial economies, the digital economy has emerged as a new economic form in recent years” (Pan, 2022). The digital economy has become more significant in economic and social activities.

This research observed the affecting mechanism of quality of human capital and digitalization on upgradation of industrial structure of Asian countries over three different mediating factors such as institutional quality, unemployment rate and research and development expenditures by government. Among those, equation 1 show the mediating effect of institutional quality, equation 2 represent the mediating effect of unemployment while equation 3 show the mediating effect of research and development expenditures.

$$ISQ_t = \alpha_0 + \alpha_1 HQL_{it} + \alpha_2 DIG_{it} + \alpha_3 INF_{it} + \alpha_4 YPC_{it} + \alpha_5 FDI_{it} + \alpha_6 HTX_{it} + u_i + v_{it} + \varepsilon_{it}$$

(1)

$$UEM_t = \alpha_0 + \alpha_1 HQL_{it} + \alpha_2 DIG_{it} + \alpha_3 INF_{it} + \alpha_4 YPC_{it} + \alpha_5 FDI_{it} + \alpha_6 HTX_{it} + u_i + v_{it} + \varepsilon_{it}$$

(2)

$$RAD_t = \alpha_0 + \alpha_1 HQL_{it} + \alpha_2 DIG_{it} + \alpha_3 INF_{it} + \alpha_4 YPC_{it} + \alpha_5 FDI_{it} + \alpha_6 HTX_{it} + u_i + v_{it} + \varepsilon_{it}$$

(3)

In above equations, IDS represent the transformation and upgradation of industrial structure of an economy *i* in time *t*. HQL is quality of human capital, DIG shows the digitalization, inflation is INF, per capita GDP is

YPC, foreign direct investment is FDI, and HTX show export of high technology products. u_i is

an “individual fixed effect”; v_t is a “time fixed effect”; ϵ_{it} is a “random error term”.

Table 3.1: Variables Description

Study used three models consisting of the following variables.

Type	Variable name	Symbol	Variable definition /proxy
Dependent variable	Digitalization	DIG	Index system
Independent variable	Human capital	YPC	High school enrollment ratio
Mediating variable	Institutional quality	ISQ	Index
Mediating variable	Unemployment	UNE	Workers unemployed
Mediating variable	Research and development	RAD	Percentage of government expenses
Control variable	Inflation	INF	CPI
Control variable	High technology product	HTX	Total exports
Control variable	Foreign Direct Investment	FDI	Foreign Direct Investment (%)

3.2 Data source :

This study used data from 30 Asian countries from 1995 to 2022. Data mainly collected from the World Development Indicators. The data of institutional quality is obtained from world governance indicators while research and

development are considered as a percentage of government expenditures and employment shows the employment rate in a country. The data is available on the official websites of the World Bank, world governance indicators and CEIC.

Table 3.2: List of countries

Afghanistan	Cambodia	Iran	Nepal	Saudia Arabia
Armenia	China	Iraq	North Korea	Singapore
Azerbaijan	Cyprus	Israel	Oman	Sri Lanka
Bahrain	Georgia	Japan	Philippines	Turkey
Bangladesh	India	Jordan	Qatar	UAE
Bhutan	Indonesia	Malaysia	Russia	Yamen

4.Results and Discussion

Table 4.1: Descriptive statistics

Variables	Observations	Z Mean value	Standard deviation	Minimum value	Maximum value
High quality labor (HQL)	432	0.222	0.124	0.073	0.768
Digitalization (DIG)	432	1.397	0.745	0.665	5.297
Inflation (INF)	432	0.021	0.006	0.006	0.043
Per capita income (YPC)	432	0.822	0.2969	0.269	1.480
Foreign Direct Investment (FDI)	432	0.019	0.017	0.012	0.121
Export of high technology product (HTX)	432	5.99	1.312	2.45	8.155
Research and development (R & D)	432	39.09	24.28	5.192	143.89

Before discussion on the empirical results, a summary of correlation and descriptive statistics are provided in above table. Mean and standard

deviation of 432 values are given of all variables of model.

Table 4.2 : Hausman test

Chi 2	3.87
P- value	0.5678

To regulate the correct estimation between random effect and fixed effect methods, study used the null hypothesis and preferred random effect model over fixed effect model on the basis of results. The value of Hausman test p-value is

0.56 that is greater than 0.05, so accept the null hypothesis and reject the alternative hypothesis by considering the random effect model effective.

Table 4.3 : Random effect test

Variables	Coefficient	Z	P > z
HQL	0.7978918	9.24	0.0000
DIG	0.366647	2.40	0.045
INF	0.8071913	8.56	0.002
YPC	0.80719	0.61	0.000
FDI	0.465785	3.73	0.0343
HTX	0.5893773	3.16	0.002

RND	0.8934	5.78	0.016
ISQ	0.8994355	3.19	0.000
UNM	-0.98473	2.12	0.545
Constant	12.26114	3.16	0.002
Observations	432	432	432
R ²	0.984	-----	-----

Human capital is connected positively with the digitalization described as 1 % increase in the digitalization can be obtained by 0.7978918% acceleration in human capital. The finding supported by the Zhang et al. (2023) who emphasized on the role of labor force as important production factor in Asian countries . Secondly, results stated that 1% increase in the digitalization cause 0.8071913% rise in the level of inflation that is alarming situation in the economy. Moreover, the 1 percent rise in the digitalization cause rise of 0.80719 percent rise in the per capita income of an economy. Foreign Direct Investment just raised 0.465785 percent due to rise of 1 percent in digitalization. To accomplished the objectives of the study institutional quality and research and development all have positive coefficient that shows the increase of 0.8994355 percent and 0.8934 percent respectively will gain through increase of 1 percent of digitalization. While on the other hand there is negative impact on unemployment.

5.Conclusion and policy implementation

From the results, study concluded that the adoption of digital technology and human capital are important for the economic growth of Asian countries. Without the support of digitalization these countries cannot compete European countries in GDP and they also need to invest more in sources that improve human capital. Adoption of digitalization bring efficiency, reduces emission and create new opportunities. The study fully described the performance of human capital in the process of industrialization.

The study developed a conceptual framework to

justify the models and role of mediating variables in the path of digitalization and human capital. Data used in study is from 1995 to 2022 of 30 Asian countries. The variables used in the study are digitalization, high technology product, foreign direct investment, per capita income and as a mediating variable study used institutional quality, unemployment and research and development.

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Contribution of the article are. First, it improves the research viewpoint of industrial sector. Secondly, it considers human capital as moderating variable. Thirdly, it considers institutional quality, unemployment and

research and development as mediating variable. Last but not the least, study contribute in the context of labour market transformation.

Based on the answers of the study, some recommendations are suggested: To maintain the institutional quality better for digitalization and provide job opportunities to the number of people by digitalization and invest a lumpsum amount on the research and development to make more progress of industrial sectors.

5.1 Study limitation

Study restricted the use of some detailed estimations such as unit root test, cross-section independence and cointegration due to lack of data availability. Further study needs to develop the digital adoption index and need to used specific technique to obtained more accurate results.

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