

THE INTERPLAY OF ADVANCED MANUFACTURING CAPABILITIES BETWEEN DIGITAL TECHNOLOGY SELF-EFFICACY, INTERNATIONAL TECHNOLOGICAL RESOURCES AND SUSTAINABLE DEVELOPMENT PROGRAMS IN SMES OF PAKISTAN

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Abstract

The business field has revolutionized by emerging technological advancements by offering significant opportunities to SME sector to be sustainable. Digital technology self-efficacy and international technological resources have been incorporated for assessing their impact on transform manufacturing capabilities to ensure sustainable development. This research contribute to body of knowledge by expressing the role of digital technology self-efficacy for optimal efficiency in manufacturing capabilities. The research is novel in expressing and investigating the influence of international technological resources on advanced manufacturing capabilities, which further assist in attaining sustainable development programs at the SME sector of diverse categories in Pakistan. The snowball sampling technique was implied for data collection from managers in five major SME hub cities of Pakistan. The collected data was analyzed on Smart PLS 4.0 for measurement model assessment and structural equation model for hypothesized relationship investigation. The study's finding reported statistically significant relationships between digital technology self-efficacy and advanced manufacturing capabilities, between international technological resources and advanced manufacturing capabilities. The advanced manufacturing capabilities ensure sustainable development programs. Further, the advanced manufacturing capabilities significantly mediates the relationship between exogenous and endogenous constructs. In nutshell, direct and the mediating hypotheses of research framework reported to be statistically significant. The limitations, future research avenue and suggestions for the manager of SME sector are stated to attain sustainability.

Keywords: Small and Medium Enterprises (SME), Digital Technology self-efficacy (DTSE), International Technology Resources (ITR), Advanced Manufacturing Capabilities (AMC), Sustainable Development Programs (SDP)

INTRODUCTION AND BACKGROUND

Unsustainable manufacturing resources are a crucial issue in a globally viable business environment, and increased involvement in international markets, while focusing on attracting more customers. Greening initiatives tend to attract potential customers that enabling firms to address the emerging and adoptive phenomenon of sustainability. In today's global environment, socially responsive programs are much needed from manufacturers to do good for society. This is one of the questioned phenomena due to failure in sustainable development achievement as the majority of manufacturers failed to transform operations to meet the required sustainable prerequisites (Gould & Colwill, 2015; Jiang et al., 2016). Increased digitalization requires the latest technologies that contribute to achieving sustainable development. The Industrial Revolution 4.0 has emerged as the most effective technological package to support and enhance manufacturing capabilities that enable firms to achieve sustainability. Researchers have embarked on the phenomenon of digitalization and the role of IR by introducing the latest technologies to contribute in advanced manufacturing patterns (Lopes de Sousa Jabbour et al., 2018; Javed, T., Azhar, J., 2025).

Traditional manufacturing has been transformed due to intensive dependency and utilization of digital technologies, which has occurred as a major challenge in adoption due to the required skill set, finance, and

complex operational issues in devising reprocessing and engineering (Raj et al., 2020). Technological advancements contribute to enhancing visibility, supply lines become efficient, real-time data can be assessed, and overall performance can be improved. Organizational learning, which contributes to efficient production, enables recycling, refurbishing, and remanufacturing can be incorporated (Tortorella et al., 2020). The implementation of industrial revolution technologies provides standardized operations for optimization by significantly reducing resources and lead times. In a volatile business environment, firms participate in manufacturing and recycling but faces lot of issues and problems that create uncertainty, bottleneck supplies, loss in production, inventory mismanagement, delayed orders, dispatching issues, and inefficient resource utilization, which overall compromises operational performance (Bag et al., 2020).

Sustainable development is necessary for manufacturing firms, as it is a prime concern for highly technological-oriented firms for the transformation of existing product design, service, and utilization of diverse resources that compromise the environment and cause global warming, while focusing on competitiveness in the international market. The development of advanced capabilities to manufacture by utilizing the latest technologies by rethinking, redesigning, reducing, reusing, repairing, refurbishing, repurposing, recycling, and recovering for cleaner production, which contributes to the economy and assists firms to achieve a competitive edge (Kirchherr et al., 2017).

The preservation of resources and effective management of existing resources for operational needs without sacrificing or compromising the needs of future generations is referred as sustainability. This phenomenon is not only associated with natural resources but also encompasses a socio-economic perspective, not only relevant to environmental sustainability but also a socio-economic sustainability. The focus is to serve existing individuals without compromising the quality of life of coming generations. It is also referred to as the procedure, which aims to enhance long-term financial stability and quality of life without compromising the quality of life for the coming generation and to satisfy their needs and requirements. Sustainability has worth to be considered and researched as it has received much attention of researchers due to its crucial impact for development, and in a future perspective, it is significant for each industry and society (Degai & Petrov, 2021).

Sustainable development is relevant in every industry and provides a comprehensive understanding and helps in transforming existing practices into a sustainable perspective (Gooroochurn & Toolsy, 2021). The current digital era requires emerging digital business practices to pursue business electronically to cope inclined electronic commerce phenomenon. Technological business startups have grown in recent years due to the intensive utilization of electronic means for conducting business. Electronic business practices have enabled business owners to acquire new horizons due to the utilization of electronic means and social media for marketing processes and transactions (Wibowo & Haryokusumo, 2020; Hong et al., 2021). Digitalization has the potential to enrich benefits as internet users have dramatically increased throughout the world. Internet users have increased around the world in recent years which has opened opportunities for emerging startup businesses. The emergence of the digitalization era has provided the landscape for startups in electronic commerce. The potential emergence is based upon fewer restrictions of time, cost and space. This enables marketing effectiveness, reduces operational costs and increases market share. Meanwhile, consumers harvest benefits by reducing transaction costs and time, as well as taking advantage of the ease of electronic payments to purchase desired products. The E-commerce sector has observed promising growth with exponential digital techno setups that boosted the business startups during the pandemic even (Pasigai & Jusriadi, 2024).

Digitalization has become a protagonist device that tackles business issues and problems, while converting existing practices and turning them into significant achievements. Autonomy plays a significant role and encourages individuals to establish businesses in a developing economy. Digital innovation, technological orientation, and digital technology self-efficacy, along with entrepreneurial initiatives, boost the firm's experience and performance. Organizations find solutions in technologies and focus on adopting and implementing the latest packages for harvesting benefits. Digital technologies' self-efficacy imbues confidence in individuals to tackle problems of digital technologies (El-Sisi, 2022).

The confidence and competence of an individual who works and engages with digital technologies are expressed by the concept of digital technologies self-efficacy. The digital technologies enable the firms to enhance productivity due to ease of usage, and technological advancements also facilitate learning and reduce consumption time and resources (Kundu, 2020). The belief of an individual in competency enhances the level of

innovation based on information back-up, clearing, and deletion of the individual's digital practices significantly related to mobile self-efficacy. On the other hand, it has been argued that the internet and emails are irrelevant on increasing the level of information among stakeholders; however, it is somewhat related to e-learning preparedness and e-learning self-efficacy (Ali & Warraich, 2022). The lack of technological adoption for supportive, sustainable business models and performance is always been highlighted in emerging economies. Innovative technologies are essential in today's world and can contribute in enhancing competitive position through improvement in performance. Mergers and acquisitions support technological adoption to enhance performance among small and medium enterprises (Dickson et al., 2021). It is evident that the adoption of international technology produces higher benefits for firms in a turbulent market; the installation of foreign technologies is closely related to venture formation for performance, which depends upon the innovative capabilities of SMEs (Adam & Alarifi, 2021).

Sustainability has emerged as a crucial element in today's world, which is significantly desired for any industry or society. It has also become most translational research issues among researchers, because absence of a standard definition of sustainability and the profusion of synonyms used to allude in research. It is challenging to define, assess, investigate and implement the standard definition of sustainability; academicians and professionals use and state the concept differently and express it in various possible meanings (Virtanen et al., 2020). The list is loaded with another ambiguous phrase, sustainable development. There is a shortage of precise and simple definitions in the literature on sustainable development (Leal Filho et al., 2021).

The circular economy is built on both manufacturing responsibility and accountability, the resources stay in the system for a long time and provide maximum value, and end of its life cycle and components are recovered (Bag et al., 2020). The advanced manufacturing capabilities require the latest research and development initiatives, such as refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover can provide options for green production can assist firms to achieve a competitive edge over competitors (Chan et al., 2018).

The SME sector is pivotal for economic strength, which accounts for 90% of the business worldwide and also provides a large job base. The SME sector contributes to innovation and economic growth. Thus, the SME sector is recognized and acknowledged as an essential sector for economic expansion and development for job creation, innovation and new business ventures, and beat competition. In Pakistan, the contribution of the SME sector is remarkable as it boosts the economic circle, provides jobs, and strengthens overall economic performance. The 30% of GDP is contributed by the SME sector, and 25% by exports, and 80% workforce is utilized in the Pakistani SME sector (Soomro et al., 2024).

Pakistan has 3.3 million SMEs, which consist of 90% of the total country's business. It promotes growth and fullness of SMEs and contributes to financial strength. However, challenges are an essential part of any business, and the Pakistani SME sector is facing a deficiency of energy, environmental concerns, and technological issues in the textile, paper, pulp, cement, steel, agriculture, and leather sectors (Kumar et al., 2022). The majority of the SMEs of Pakistan have extended their operations to exports level and pursue internationalization based on top management. The required resources for such huge operations is always an issue, such as technological resources, financial resources, human capital, knowledge management, and information access and utilization, which is largely lacking in the Pakistani SME sector (Xin et al., 2023). Thus, this study focused on Pakistani SME sector for assessing the level of interest towards the adoption of technological advancements.

The purpose of this research is to explain the phenomenon of sustainable development influenced by digital technology self-efficacy, international technological resources, and perceived sustainability through the mediation effect of advanced manufacturing capabilities. There is a need to address the relationship between digital technology self-efficacy and sustainable development. It is argued that DTSE tends to play a significant role in explaining sustainable development. The relationship between DTSE and SD is overlooked in previous literature; therefore, this research intends to express the relationship and empirically examine the relationship for a better understanding. This study also incorporated international technology resources to express the phenomenon of sustainable development with the mediation effect of advanced manufacturing capabilities. The perceived sustainability is an important factor in expressing sustainable development with the mediation effect of advanced manufacturing capabilities.

LITERATURE REVIEW

This section entails a detailed discussion on the relationship between variables and the formation of hypothesized arguments.

DIGITAL TECHNOLOGY SELF-EFFICACY AND ADVANCED MANUFACTURING CAPABILITIES

At present, digitalization has changed the basis of competition as it has emerged as a protagonist device that contributes to achieve a higher level of optimization, profit and efficiency, which leads to accomplishing the ultimate objective of the business operation. Digitalization has gained attention in recent decade due to its significant impact on performance-related outcomes. It has encouraged firms and individuals to establish their own businesses in developing nations, the innovation is based on digital advancements, and technological orientation has emerged as an essential element. Most importantly, digital technology self-efficacy is required for the achievement of an optimal level of output (Ali & Warraich, 2022). There is a dire need to become technologically oriented for the adoption and implementation of such technological advancements that contribute to providing solutions for organizational issues and enable to introduce new products, designs, and markets. The digital technology self-efficacy enables individuals and firms to build confidence to tackle the technological issues (Bamgbade et al., 2022).

The concept of DTSE expresses the confidence and competence of an individual to work and get engaged with digital technologies, the belief of an individual to be at ease of use with a digitalized working environment, and enhance productivity, while facilitating learning and time saving. The level of innovation is also related to digital self-efficacy, which enriches the belief of having competency. There are various factors that impact self-efficacy and alter the business operations (Mancha & Shankaranarayanan, 2021). The prior literature has embarked on the influential capabilities of digital self-efficacy on e-learning. The effective the learning, the more efficacy can be achieved for the adoption of digital technologies (Tripathi et al., 2022). The researchers have also incorporated the personality factor to establish the relationship between self-efficacy and usefulness with the perceived ease of use. The study revealed that the utilization of digital applications by employees enables them to develop professional competency and is significantly correlated (Hasgall & Shoham, 2015).

Previously, the researchers have focused on explaining the phenomenon of digital technology self-efficacy in relation to digital innovation and digital entrepreneurship. The study also examined the relationship between technology orientation and digital innovation and entrepreneurship; further, the role of entrepreneurial orientation was explained to predict digital innovation and entrepreneurship. The findings revealed that technology orientation, entrepreneurial mindset, and digital innovation predict digital entrepreneurship. Interestingly, the digital technology self-efficacy was not significantly related to digital innovation and entrepreneurship; further, digital innovation has no significant mediation effect between digital technology self-efficacy and digital entrepreneurship (Lingfu et al., 2024).

This study argues that digital self-efficacy tends to influence performance-related outcomes because the nature of competencies is significantly predictive. The study adopted the notion of the Resource-based view theory that internal competencies enable the firms to gain a competitive advantage. Similarly, the competency of digital technology self-efficacy is capable to alter the advanced manufacturing capabilities, which enable the firms to gain sustainable development. Thus, the following hypothesis is formed:

H1: *The Digital Technology Self-Efficacy is influential to Advanced Manufacturing Capabilities among the SME sector of Pakistan*

INTERNATIONAL TECHNOLOGY RESOURCES AND ADVANCED MANUFACTURING CAPABILITIES

A significantly important perspective of RBV is to assess the international resources involvement in deriving sustainable performance. The tangible and intangible resources play an important role in performance-related consequences. The capabilities and competencies of the firm could push the business ahead in competition at a global level while focusing on its core goals and by utilizing its expertise. It was further verified in literature that resources and capabilities of the firm assist in the achievement of firms' goals and objectives, with higher performance and in accomplishing a competitive edge (Wrede & Dauth, 2020).

Technological upgradation has taken place rapidly in recent decades; however, several challenges have been faced by firms, including a lack of technological support in ensuring business performance and productivity. Technological innovation has emerged as a necessity of any business, which enhances performance hike by

enriching technological capabilities. Therefore, firms strive to adopt and implement the latest advanced technological solutions that significantly enhance the performance (Anwar & Ali Shah, 2020). The strategic move of merging or acquisition can also be adopted to support technological alignment for the achievement of performance-oriented goals and objectives. Simply, the SME firms are encouraged to adopt technological advancements to survive in the market and compete via international technology. The turbulent market requires technologically advanced resources and solutions to compete; foreign technologies can also be incorporated through merging and forming new business ventures. The innovative capabilities of SMEs enable to innovate in manufacturing, which further leads to sustainability (Dickson et al., 2021).

In addition to that, domestic SMEs are found to be striving for implementing international technologies to operate their business operations for enhancing productivity, quality, structure, and design. The previous literature has shown that newer technologies have more potential for the SME sector, which enables it to contribute to economic strength. Therefore, the managers in top-notch firms encourage to opt latest advanced technologies to increase efficiency and to achieve a competitive edge. Innovative firm always seeks for international opportunities to enhance performance and take advantage for market turbulence (Jewell et al., 2022).

Previously, the research has been incorporated the crucial variables of international financial resources and international technological resources to influence sustainable performance with the mediating effect of green entrepreneurial orientation among SME sector of Pakistan. The study was based on the argument that international involvement in terms of finance and technology transfer has a certain effect on performance-related dimensions and also contributes to higher productivity. The notion of RBV theory posits that international financial and technological resources are considered as competency of the firm, which contributes in achievement of organizational goals, objectives and financial growth. The study revealed that international financial resources have favorable and substantial influence on long-term performance of firm, interestingly international technological resources has no significant impact on sustainable performance (Xin et al., 2023).

This study focused on crucial technological factor for assessing the relationship with advanced manufacturing capabilities, which further ensures sustainable development. The researcher argues based on RBV theory that international technological resources are suitable for SME sector to boost existing productivity and performance to meet the demand and achieve a competitive position. Similarly, the advanced manufacturing capabilities can be enhanced in the presence of international technological resources, which further expected to ensure sustainable development. Thus, the following hypothesis is derived for examining:

H2: *The International Technological Resources are influential to Advanced Manufacturing Capabilities among the SME sector of Pakistan*

ADVANCED MANUFACTURING CAPABILITIES AND SUSTAINABLE DEVELOPMENT PROGRAMS

The management of resources with the intention to preserve for future generations is expressed as sustainability. The idea isn't limited only to the environmental perspective but also preservation of natural resources found on earth; further, it is extended to the socioeconomic sustainability. The prime purpose is to serve the needs of the present generation without sacrificing the quality of life of future generations. Sustainable development is expressed as the procedure that aims to enhance long-term financial benefits while ensuring living standards and also ensuring a similar quality for future generations (Degai & Petrov, 2021). The combination of techniques, activities, and strategies for production and manufacturing through economically effective processes, which also minimize adverse environmental impact, conserve energy and natural resources, and benefit valuable stakeholders, including employees, consumers, and communities, ensures welfare and safety (Machado et al., 2020).

Sustainable manufacturing involves various processes, more sustainable products to deliver economic, social, and environmental benefits. It also holds a holistic view that the product life cycle and value creation contribute to sustainability. The economic-manufacturing sustainability pillar denotes that manufacturers to operate profitably to pursue sustainable goals (Yong et al., 2020). The advanced technological solutions and applications are required for effective economic and sustainable development. Smart manufacturing run the production by adopting the latest technologies to build advanced manufacturing capabilities that can assist in transforming existing traditional operations to harvest more economical benefits (Cecconet et al., 2018).

Developing advanced manufacturing capabilities stems from research and development, the advanced manufacturing approaches are based on the latest technologies that address the refuse, reduce, repair, reuse, rethink, refurbish, remanufacture, repurpose, recycle, and recover can provide a suitable environment and cleaner production that enable the firms to gain a competitive advantage. The utilization of digital technologies enhanced the productivity and enriched the manufacturing operations, which contribute to sustainable development (Chan et al., 2018). The advanced manufacturing technologies help in operations, while reducing cost, increasing productivity and efficiency, reducing wastage, enhancing recycling, and contributing to attain sustainability (Hannibal & Knight, 2018). The cost reduction is declared as the most influential driver for sustainability, which controls wastage and recycles effectively. These latest technologies enhance the information sharing vertically as well as horizontally throughout the firm. The newer concepts have emerged as well, which tend to reshape the processes and has potential to contribute for further developments.

Based on above literature the following hypothesis is derived:

H3: *The Advanced Manufacturing Capabilities are influential to Sustainable Development among the SME sector of Pakistan*

THE MEDIATION EFFECT OF ADVANCED MANUFACTURING CAPABILITIES

This section entails the discussion and synthesizes the literature to express the mediation effect of advanced manufacturing capabilities.

The volatile business environment creates a number of issues and problems, including compromised quality, higher cost, and problems in recycling with a higher level of uncertainty. The supply also faces the issue of bottlenecks, production losses, inefficient inventory, disruption in sales, and trouble in dispatching which negatively impact operational performance (Inderfurth, 2005). The uncertain environment also causes poor decision-making, which leads to crises in various nodes of business operations and ultimately reduces profit margin. The disruption in supply chain also impacts manufacturing and causes higher backlogs, which leads to lower production and negatively impacts customer satisfaction. These issues has been faced by the SME sector of Pakistan and caused a reduction in product efficiency and compromised performance. For this purpose, advanced technologies are highly recommended to be utilized for manufacturing and at all production stages, from procurement to after-sales services (Bag et al., 2019).

Previously, research studies have been conducted to express the phenomenon of sustainable development influenced by the degree of industrial revolution technologies that influence advanced manufacturing capabilities, it further leads to achieving sustainable development. The study argued that the implementation of digital technologies is a prime concern to achieve sustainable development. The study reported significant results that the implementation of digital technologies enables firms to gain sustainable development (Bag et al., 2021). This research effort incorporated the mediation effect of advanced manufacturing capabilities between independent and dependent variables. The researcher argues that the implementation of the latest technologies contributes in the achievement of sustainable development; this relationship is worthwhile with the interplay of advanced manufacturing capabilities. The advanced manufacturing capabilities mediates the relationship between digital technologies self-efficacy and sustainable development. Similarly, the advanced manufacturing capabilities mediate the relationship between international technology resources and sustainable development.

Thus, the following mediating hypotheses are formed to examine the effect:

H4: *The Advanced Manufacturing Capabilities mediate the relationship between Digital Technology Self-Efficacy and Sustainable Development among the SME sector of Pakistan*

H5: *The Advanced Manufacturing Capabilities mediate the relationship between International Technology Resources and Sustainable Development among the SME sector of Pakistan*

RESEARCH FRAMEWORK

The research framework is shown in figure 1, which depicts the variables of the study and demonstrates the hypothesized relationships to be investigated. The exogenous constructs are Digital Technology Self-Efficacy (DTSE) and International Technology Resources (ITR), the endogenous variable is sustainable development (SD), and the mediating variable is Advanced Manufacturing Capabilities (AMC).

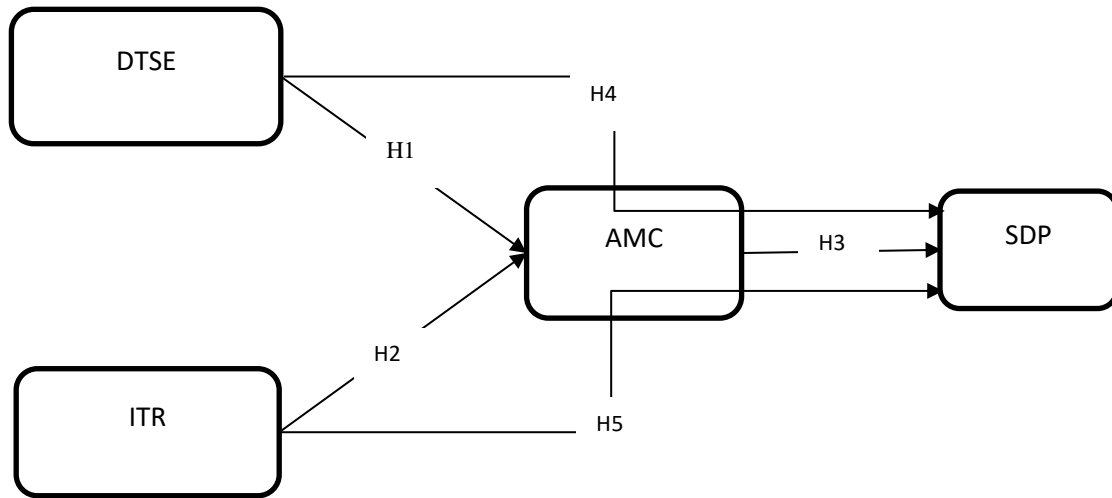


Fig 1 Research Framework

Note: DTSE (Digital Technology Self-Efficacy), ITR (International Technology Resources), AMC (Advanced Manufacturing Capabilities), SDP (Sustainable Development Programs)

RESEARCH METHODOLOGY

This section presents the research methodology section, which entails research design, population and sample, sampling technique, and research instruments.

The quantitative method is applied in the present research due to valid and reliable techniques, which can provide neutral results, as valuable data was collected from reliable sources. A quantitative approach suits in analytical examination, which is necessary for measuring the internal coherence that underpins the relationship between the variables of the study to express the phenomenon of sustainable development (Bell et al., 2022).

POPULATION AND SAMPLE

This research focused on the SMEs sector operating in the volatile market and economy of Pakistan. There are approximately 3.2 million firms in Pakistan, and SMEs substantially contribute to economic development. This research was conducted on five major cities of Pakistan considered as hub for business, including Faisalabad, Gujranwala, Lahore, Rawalpindi, and Sialkot. The researcher specially targeted the firms involved in international trade and operations; the list was available on request from the Chamber of Commerce of the relevant constituency. The total of 5370 registered SMEs was on the list that could be the potential respondents. The SMEs were selected from different categories, including textile, sports, surgical instruments, sanitary, and appliances industries, closely related to manufacturing. The snowball sampling technique was applied as it is suitable in this situation to reach the appropriate respondents. In total, 357 SMEs were targeted as the respondents were managers of firm, and data was collected from managers only. The sample size of 357 was justified by determining the sample size table of (Krejcie & Morgan, 1970). Therefore, 537 questionnaires were distributed to get the maximum number of responses for generalizability. The researcher received 301 usable responses, yielding a 56% response rate overall for data analysis.

MEASUREMENT SCALES

The measurement scales of each variable were utilized and adopted from prior literature. Each item was measured on a 5-point Likert scale ranging from strongly disagree to strongly agree. Strongly disagree is denoted by 1, disagree is denoted by 2, neutral is denoted by 3, agree is denoted by 4, and strongly agree is denoted by 5. The measurement scale of the sustainable development program was adopted from (Raza et al., 2023). The scale consists of 5 items. The measurement scale of digital technology self-efficacy (DTSE) was adopted from the study of (Lingfu et al., 2024), the scale consists of seven items. The 3-item measurement scale of International Technological Resources (ITR) was adopted from the research paper of (Xin et al., 2023). The 10-item

measurement scale of the advanced manufacturing capabilities was adopted from (Bag et al., 2021). For the detailed questionnaire, please see Appendix 1.

DATA ANALYSIS

This section entails the data analysis of collected responses to determine the hypothesized relationships between variables as depicted in the research framework Figure 1.

The questionnaire was distributed among 537 startup owners and received 301 complete and usable responses, the total response rate was observed to be 56% which is acceptable for data analysis. There were 271 respondents were male members, and 30 were females, 126 respondents were graduated, and 175 were enrolled in Master level.

MEASUREMENT MODEL ASSESSMENT

The analysis section entails two sub-sections: the measurement model and the structural equation model. In the first section reliability and validity are determined based on statistical test. The Smart-PLS was utilized for data analysis. The PLS algorithm method was utilized for assessing the reliability and validity of the constructs. Reliability is determined on the base Cronbach alpha (α) and composite reliability. The convergent validity is also determined in the first section. The value of Average Variance Extracted (AVE) is determined for the achievement of convergent validity. Table 1 demonstrates the reliability and validity results.

Table 1

S#	Constructs		Loading	Alpha	CR	AVE
1	DTSE (Digital Technology Self-Efficacy)	DTSE1	0.594	0.921	0.938	0.688
		DTSE2	0.691			
		DTSE3	0.88			
		DTSE4	0.922			
		DTSE5	0.909			
		DTSE6	0.873			
		DTSE7	0.877			
2	AMC (Advanced Manufacturing Capabilities)	AMC1	0.72	0.936	0.940	0.635
		AMC10	0.794			
		AMC2	0.79			
		AMC3	0.842			
		AMC4	0.818			
		AMC5	0.754			
		AMC6	0.843			
		AMC7	0.798			
		AMC8	0.844			
		AMC9	0.754			
3	ITR (International Technology Resources)	ITR1	0.922	0.936	0.936	0.886
		ITR2	0.96			
		ITR3	0.942			
4	SDP (Sustainable Development Programs)	SDP1	0.85	0.768	0.825	0.526
		SDP2	0.82			
		SDP3	0.795			
		SDP4	0.279			
		SDP5	0.726			

Note: DTSE (Digital technology Self-Efficacy), AMC (Advanced Manufacturing Capabilities), ITR (International Technology Resources), SDP (Sustainable Development Programs)

The above table presents the result of PLS algorithm while demonstrating Cronbach alpha, CR and AVE. It has been suggested to assess the reliability and validity of the criteria of (Hair Jr et al., 2014). The cutoff point for Cronbach alpha is 0.70 at minimum for acceptable reliability, the higher reliability 0.80 considered as good reliability and higher than 0.90 is considered as excellent reliability. The value of CR also presents the internal consistency and reliability cutoff point is 0.70 as an acceptable value, higher than 0.80 and 0.90 are considered

as good and excellent reliability respectively. Convergent validity is determined based on AVE value, the value must remain higher than 0.50 for acceptable convergent validity. It is evident in Table 1 that all the constructs meet the criteria of reliability and validity based on their values. Hence, this section satisfies the criteria of reliability and validity.

DISCRIMINANT VALIDITY

Discriminant Validity is also determined in the first phase of analysis which depicts the validity of the construct that the items are distinct to each other and measure different variables. The square root of AVE must remain higher than other correlational values for the achievement of discriminant validity. Table 2 demonstrates below for assessing the values based on (Fornell & Larcker, 1981) criteria.

Table 2: (Fornell and Larcker, 1981)

Constructs	AMC	DTSE	ITR	SDP
AMC	0.797			
DTSE	0.538	0.829		
ITR	0.513	0.709	0.941	
SDP	0.548	0.531	0.510	0.725

Note: DTSE (Digital technology Self-Efficacy), AMC (Advanced Manufacturing Capabilities), ITR (International Technology Resources), SDP (Sustainable Development Programs)

The above table 2 demonstrates discriminant validity results that achieve the criteria for acceptability. This shows that measurement model assessment verifies the first stage of reliability and validity and data is fair to proceed further for investigating the hypothesized relationships. The figure 2 below presents the measurement model assessment extracted from PLS.

Hetrotrait-Monotrait

This section presents the value for HTMT, which is assessed on PLS by PLS algorithm method that depicts the discriminant validity. This ration determines the distinction between variables. The value should not exceed 0.85 for acceptable distinction. The Table 3 below demonstrates the values for HTMT, which satisfies the criteria.

Table 3: HTMT

Constructs	AMC	DTSE	ITR	SDP
AMC				
DTSE	0.570			
ITR	0.544	0.758		
SDP	0.582	0.611	0.576	

Note: DTSE (Digital technology Self-Efficacy), AMC (Advanced Manufacturing Capabilities), ITR (International Technology Resources), SDP (Sustainable Development Programs)

The figure 2 below is extracted from Smart PLS, this demonstrates the measurement model assessment along with outer loading, Cronbach alpha, composite reliability, and average variance extracted.

STRUCTURAL EQUATION MODEL

This section enables the researchers to execute a bootstrapping method for assessing hypothesized relationships as depicted in the research framework. The relationships are examined on the given criteria of assessing β -value, t-value and p-value. The cutoff point for the t-value is fixed at 1.96 with a 5% error margin and the p-value must be lower than 0.05 for the acceptable significance of the relationship (Hair Jr et al., 2014). The results are presented in this section of each relationship and discussed.

ASSESSMENT OF HYPOTHEZED RELATIONSHIPS AND DISCUSSION

Hypothesis H1 determines the association between digital technology self-efficacy (DTSE) and advanced manufacturing capabilities (AMC). The researcher argued that belief of an individual or firm to utilize technology in the better, more efficient and in effective way to harvest the long-term benefits. The researcher argued that digital technology self-efficacy tends to increase the internal manufacturing capabilities among SME sector. Hence, the study is conducted on SME sector of diverse categories and each category requires diverse technological applications. The manufacturing capabilities must be unique to take a competitive advantage and that is influenced by the potential self-efficacy to utilize digital technologies. The result of the hypothesis is given in Table 4 below, which shows statistically significant results, and hypothesis H1 is accepted. The β -value

is 0.349 showed a strong relationship; the t-value was found to be higher than 1.96 and reported as 4.497, and meanwhile p-value was observed to be lower and in an acceptable range, which is 0.000, showing the relationship is verified that digital technology self-efficacy tends to increase advanced manufacturing capabilities.

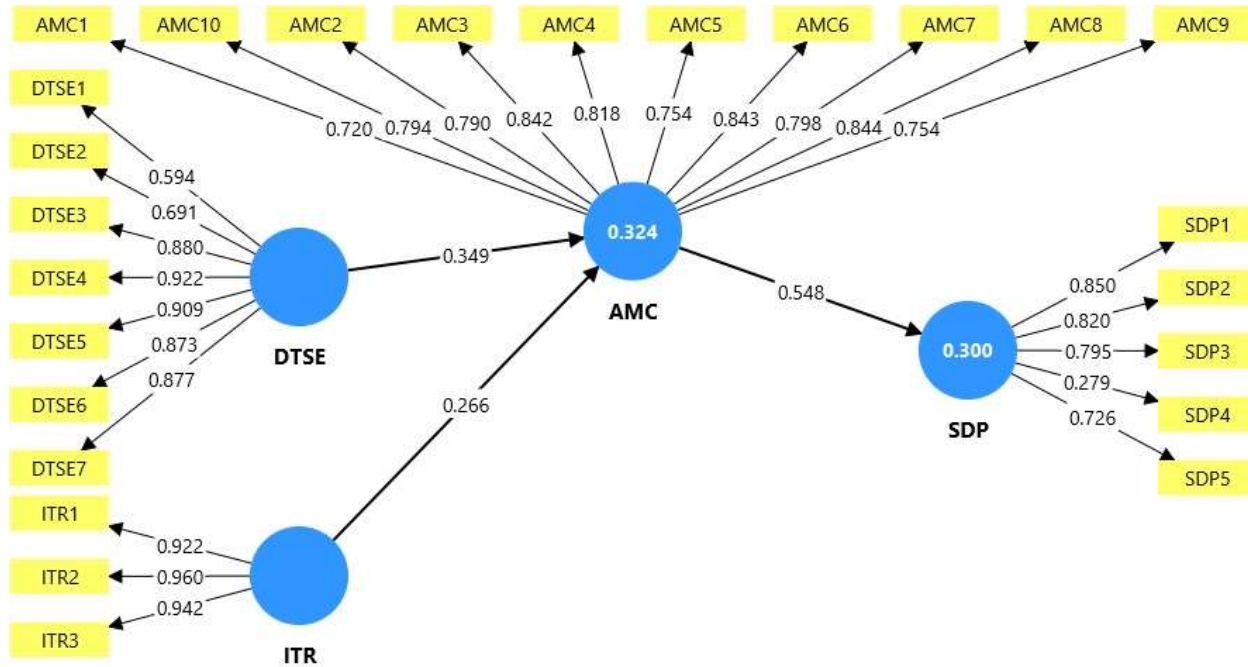


Figure 2, Measurement Model Assessment

Note: DTSE (Digital technology Self-Efficacy), AMC (Advanced Manufacturing Capabilities), ITR (International Technology Resources), SDP (Sustainable Development Programs)

The result of the present study is aligned with previous literature, which depicted the significant results and relationship between digital technology self-efficacy and the capability to increase performance. Contrary to prior literature that reportedly claimed a significant relationship has been claimed that digital self-efficacy tends to predict higher performance (Ali & Warraich, 2022). Another identical study also depicted that digital self-efficacy increases the e-learning capabilities (Mancha & Shankaranarayanan, 2021). The findings of this study also verify the notion that RBV and internal capabilities increase the performance-related outcomes and enable to sustain competitive edge.

Hypothesis H2 investigated the relationship between international technology resources and advanced manufacturing capabilities. The hypothesis is formed on the basis of the literature that the availability of international technological resources contributes to sustainable development. The international technology resources are a unique facility that a firm can acquire, and the effective utilization of international technological resources contributes to achieve the required goals and objectives. The results in Table 4 below show that the relationship between these variables is significant. It has been reported that the β -value is observed to be 0.266, the t-value is found at a higher level than the cutoff point and reported as 3.278, whereas the p-value is reported as 0.000. Hence, the result shows that the relationship is statistically significant. Therefore, hypothesis H2 is accepted. The findings of the present study is aligned with the findings of prior literature that international technological resources influence performance (Jewell et al., 2022). The findings also support the notion of RBV theory that capabilities predict performance-related outcomes (Xin et al., 2023); similarly, the availability of international technological resources and the ability to implement also enhance the sustainability and sustainable development programs.

Hypothesis H3 investigated the relationship between advanced manufacturing capabilities and sustainable development programs. The hypothesis is developed based on the argument that for capabilities of advanced manufacturing have the potential to predict sustainable development programs. This means manufacturing

capabilities are essential for the achievement of sustainability and effective outcomes. The result shown in Table 4 shows statistically significant results based on the β -value, which is observed as 0.548; the t-value is reported as 9.571 is above the cutoff point and the p-value is observed to be 0.000, which shows an acceptable error margin. Hence, the hypothesis H3 is statistically accepted. The findings of the current study verify the result of (Hannibal & Knight, 2018). The study reported a statistically significant relationship between advanced manufacturing capabilities and a sustainable development program.

Table 4: Direct Relationship

S#	Hypotheses	β	t-value	p-value	Decision
Direct Relationships					
H1	DTSE \rightarrow AMC	0.349	4.497	0.000	Accepted
H2	ITR \rightarrow AMC	0.266	3.278	0.000	Accepted
H3	AMC \rightarrow SDP	0.548	9.571	0.000	Accepted
Mediating Relationships					
H4	DTSE \rightarrow AMC \rightarrow SDP	0.191	3.648	0.000	Accepted
H5	ITR \rightarrow AMC \rightarrow SDP	0.146	3.070	0.000	Accepted

Note: DTSE (Digital technology Self-Efficacy), AMC (Advanced Manufacturing Capabilities), ITR (International Technology Resources), SDP (Sustainable Development Programs)

The figure 3 below demonstrates the structural equation modeling extracted from Smart PLS which shows the significance of the hypothesized relationships.

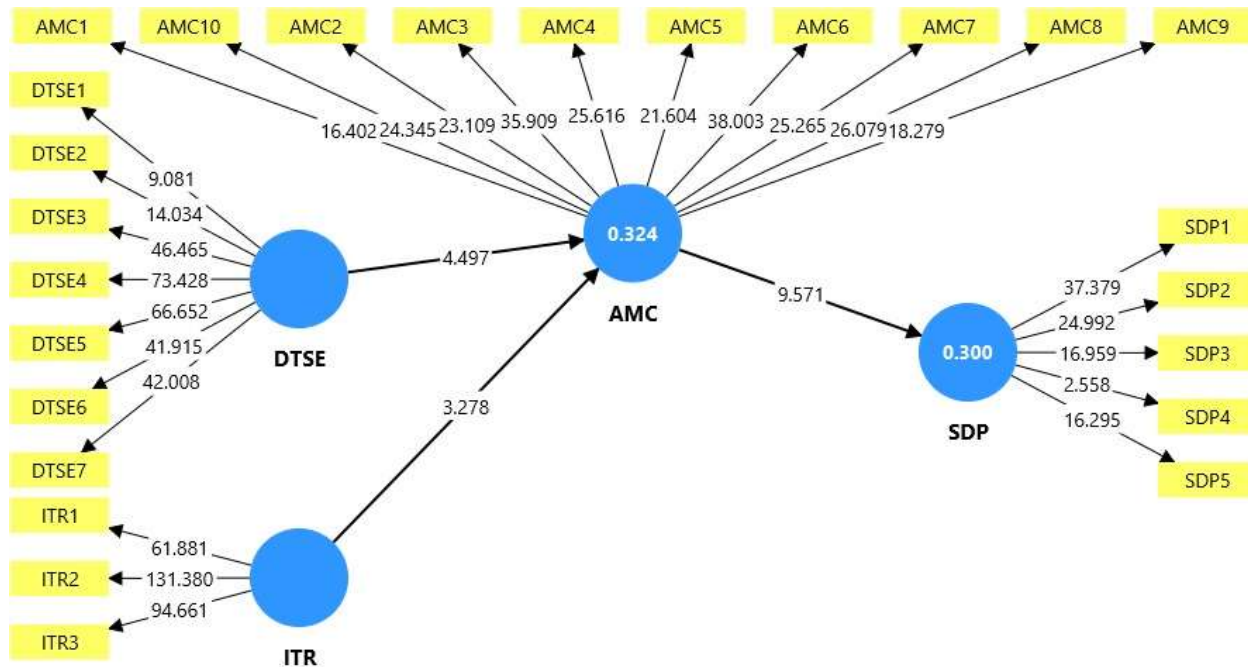


Figure 3, Structural Equation Model

Note: DTSE (Digital technology Self-Efficacy), AMC (Advanced Manufacturing Capabilities), ITR (International Technology Resources), SDP (Sustainable Development Programs)

MEDIATING HYPOTHESES TESTING

Hypothesis H4 examined the mediating effect of the advanced manufacturing capabilities between digital technology self-efficacy and sustainable development programs. The researcher argued that digital technological self-efficacy enables firms to incorporate advanced manufacturing capabilities, which further leads to sustainability. The argument is based on the literature that depicts that digital technology self-efficacy tends to transform the existing manufacturing approaches. The digital technologies enable the firms to reduce cost, improve quality, and reduce time, and effective utilization of resources by redesigning the existing processes. These changes show the capabilities of the firm to adopt and implement newer technologies for the achievement

of goals and objectives. Interestingly, the results of the study depicted that advanced manufacturing capabilities establish the relationship between digital technology self-efficacy and sustainable development programs, as shown in Table 4 significant mediation effect is reported. The result shown in Table 4 shows statistically significant results based on the β -value, which is observed as 0.191; the t-value is reported as 3.648 is above the cutoff point and the p-value is observed to be 0.000, which shows an acceptable error margin. Hence, the hypothesis H4 is statistically accepted.

Hypothesis H5 examined the mediating effect of the advanced manufacturing capabilities between international technological resources and sustainable development programs. The researcher argued that the availability of international technological resources enables firms to incorporate advanced manufacturing capabilities, which further leads to sustainability. The argument is based on the literature that the availability of international technological resources contributes to existing manufacturing capabilities and assists in gaining a technical edge. The international technological resources enable the firms to enhance performance. These changes show the capabilities of the firm to adopt and implement newer technologies for the achievement of goals and objectives. Interestingly, the results of the study show that advanced manufacturing capabilities establish the relationship between international technological resources and sustainable development programs, as shown in Table 4 significant mediation effect is reported. The result shown in Table 4 shows statistically significant results based on the β -value, which is observed as 0.146; the t-value is reported as 3.070 is above the cutoff point, and the p-value is observed to be 0.000. Hence, the hypothesis H5 is statistically accepted.

LIMITATIONS AND FUTURE RESEARCH AVENUES

This study is limited to various perspectives.

Firstly, the development of a sustainable path for the firm has emerged as the prime concern in today's highly turbulent environment. The firms strive to take such innovative initiatives that incorporate technological advancements in business operations to reduce cost, time and wastage, meanwhile to enhance performance. The sustainable development programs is such a significant and vast area of concern, but the present study incorporated digital technological self-efficacy and international technological resources to measure sustainable development programs with the interplay of advanced manufacturing capabilities. In the future, more variables and unexplored variables can be incorporated, including technological orientation, expertise, and technical exposure of employees, to predict sustainable development programs.

Secondly, the production techniques are overlooked in this study. The technical expertise are required for the adoption and implementation of technological advancements; this study focused on the role of digital technological self-efficacy and international technological resources to upgrade the existing manufacturing techniques. The relationship can be more explanatory in the presence of technical expertise. This means the SME sector is clearly lacks in such technical expertise that possesses the capabilities to adopt and implement technological resources.

Thirdly, government support is overlooked in previous studies as well as this study was limited to technological resources and digital self-efficacy. There is a dire need to incorporate government support to achieve sustainability. In the future, it is highly recommended to incorporate the government support for technological implementation and sustainability.

CONCLUSION

This research effort extended the boundary of knowledge on sustainable development programs in a highly digitalized, turbulent, competitive, and vibrant environment. Technological advancements have become an essential element in the business world in today's highly digital and competitive era. Business success and sustainability are derived through effective utilization of technological resources that contribute to advancing manufacturing techniques by changing processes and harvesting benefits, which ensure sustainability. This research focused on the digital technological self-efficacy of firms to adopt and implement the digitized and technical support system for production in the SME sector to reduce cost, time, wastage and to increase performance and efficiency. This research effort entails the crucial factor of international technological resources. The phenomenon of globalization has opened new horizons for the business world, specifically for the SME sector to contribute in international trade and strengthen the financial grounds of the parent country. The study claimed the novelty in empirically examining the independent variables, including digital technological self-efficacy and international technological resources, to predict sustainable development programs. Another

contribution of this study relates to assessing the mediating effect of advanced manufacturing capabilities between digital technology self-efficacy and sustainable development programs, between international technological resources and sustainable development programs. The sample was managers of the SME sector of diverse categories from major cities of Pakistan. The study reported a statistically significant relationship between digital technology self-efficacy and advanced manufacturing capabilities. The findings of the study claim that the SME sector firms should be progressive towards adopting and implementing digital technologies, which shows the clear stance of management towards acceptability and capability to incorporate technological advancements. The relationship between international technological resources and advanced manufacturing capabilities is also reported to be significant shows that the availability of international technological resources enables firms to alter existing production and manufacturing techniques up to international standards to compete in the global market. The SME sector of Pakistan is suggested to ensure the availability of international technology resources for attaining sustainable development programs. Similarly, the advanced manufacturing capabilities are a prime concern for ensuring sustainable development programs in the SME sector. The advanced manufacturing capabilities can be ensured and enriched by enhanced digital technology self-efficacy and international technology resources. The study also reported statistically significant result of the mediating effect of advanced manufacturing capabilities between digital technological self-efficacy and sustainable development programs. Further, the significant mediation effect of advanced manufacturing capabilities was reported between international technological resources and sustainable development programs. The findings implies that digital technological self-efficacy increases the capabilities of manufacturing, which further ensures sustainable development programs. The managers of the SME sector are suggested to enrich the firms with technological knowledge, adoption and implementation of the latest available technologies, this tends to increase the digital self-efficacy. Further, it is suggested to opt such international technologies which enable the firms to compete globally. In nutshell, the digital technology self-efficacy and availability of technological resources specifically alter and transform the manufacturing techniques relevant to the category, which leads to the sustainable development.

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Appendix-I

A research Survey for a Research Paper

This questionnaire has two sections, A&B. Please answer all the questions. There is no right or wrong answer. Your spontaneous and honest response is important to the success of this research.

Section A: Demographic Information

The questions below are related to personal data. Please **TICK** one box which is best applicable to you.

Gender

☐ Male

☐ Female

Age (Years old)

☐ 25-35

☐ 36-45

☐ 46-55

☐ 56-60

☐ Over 60

Highest Education Level

☐ Masters

☐ PhD

☐ _____

Monthly Income

☐ Below Rs.50,000

☐ Rs.50,000-100,000

☐ Rs.100,001-150,000

☐ Above Rs.150,000

Marital Status

☐ Single

☐ Married

☐ Divorced

Section B

Please encircle the appropriate number according to employees' attitude at workplace.

1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5= Strongly Agree

Digital Technology Self-Efficacy (1=Strongly Disagree; 2=Disagree; 3=Neutral; 4= Agree 5=strongly agree)

01	DTSE1	I enjoy working with digital technology	1	2	3	4	5
02	DTSE2	Digital technology doesn't cause many problems for me	1	2	3	4	5
03	DTSE3	Digital technology makes me much more productive	1	2	3	4	5
04	DTSE4	Most of the digital technologies I have had experience with has been easy to use	1	2	3	4	5
05	DTSE5	I usually find it easy to learn how to use a new software or online application	1	2	3	4	5
06	DTSE6	Digital technology helps me to save a lot of time	1	2	3	4	5
07	DTSE7	Some digital technologies definitely make learning easier					

Advanced Manufacturing Capabilities (1= Strongly Disagree; 2=Disagree; 3=Neutral; 4= Agree 5= strongly agree)

01	AMC1	Our firm focuses on making a product redundant by abandoning its function or by offering the same function with a radically different product	1	2	3	4	5
02	AMC2	Our firm focuses on making product use more intensive	1	2	3	4	5

03	AMC3	Our firm focuses on lower resource consumption and improving manufacturing efficiency	1	2	3	4	5
04	AMC4	Our firm promotes reuse by another consumer of discarded product which is still in good condition and fulfills its original function	1	2	3	4	5
05	AMC5	Our firm does repair and maintenance of defective products, so it can be used with its original function	1	2	3	4	5
06	AMC6	Our firm restores an old product and brings it up to date	1	2	3	4	5
07	AMC7	Our firm uses parts of discarded product in a new product with the same function	1	2	3	4	5
08	AMC8	Our firm uses discarded product or its parts in a new product with a different function	1	2	3	4	5
09	AMC9	Our firm recycles for processing materials to obtain the same or lower quality	1	2	3	4	5
10	AMC10	Our firm uses incineration of material for energy recovery	1	2	3	4	5

International Technological Resources (1= Strongly Disagree; 2=Disagree; 3=Neutral; 4= Agree 5= strongly agree)

01	ITR1	We use superior quality digital solutions compared to competitors	1	2	3	4	5
02	ITR2	We use digital solutions that have more features as compared to competitors	1	2	3	4	5
03	ITR3	We use totally different applications of the digital solutions from competitors	1	2	3	4	5

Sustainable Development Programs (1= Strongly Disagree; 2=Disagree; 3=Neutral; 4= Agree 5= strongly agree)

01	SP1	I am familiar with the sustainable development program of the firm	1	2	3	4	5
02	SP2	I am fully agree with the mission/vision of the sustainable development program	1	2	3	4	5
03	SP3	I consider it very important that sustainable development should be focused	1	2	3	4	5
04	SP4	Our employees are fully aware of sustainable development knowledge	1	2	3	4	5
05	SP5	I think there is no future of firm without sustainable development program	1	2	3	4	5