The Effects of Digital Technologies on Green Logistics Performance in Tanzania: A Moderation and Mediation Analysis Using PLS-SEM

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Abstract

The aim of this study was to assess the impact of digital technologies on the green logistics performance of Tanzanian procuring entities. The study was guided by the technology-organization-environment model, the Schumpeter theory of innovation, and the Unified Theory of Acceptance and Use of Technology. A total of 427 respondents were included in the study, and data were collected using the stratified sampling technique. The study employed post positivism research paradigm and involved the use of explanatory cross-sectional surveys in data collection. The data were collected by administering questionnaires and examining relevant documents. The inferential statistics analysis of data collected was conducted using Partial Least Squares Structural Equation Modeling with the help of SmartPLS 4 software. The data collected on respondents' profiles was analyzed using descriptive statistics with the assistance of IBM SPSS Statistics Version 26. The results suggest that the use of augmented reality, predictive analytics, information and communication technology (ICT) specialists, and the intention to use robots all have a beneficial impact on the efficiency and effectiveness of green logistics. The study recommends that suppliers and buyers in Tanzania and other developing countries should use robots, augmented reality, ICT specialists and predictive analytics to improve the green logistics performance.

Keywords: Augmented Reality, Predictive Analytics, Intention to Use Robots ICT Specialists, Green Logistics Performance

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Introduction

Digital technologies can have a significant impact on the efficiency of green logistics in developing countries (Ogata et al., 2022; Enta et al., 2014). Digital technologies can help reduce the environmental impact of logistics activities and support the transition to a more sustainable logistics system (Mahalakshmi et al., 2019; Hamidu, 2017; Sen, 17). They achieve this by offering greener transportation choices, enhancing visibility and control over logistics operations, and enabling the development of sustainable logistics networks (Kara & Yalçın, 2022; Moldabekova et al., 2021; Joshi & Sharma, 2022; Fan et al., 2022). In order to reduce fuel consumption and the release of greenhouse gases, digital platforms can be employed to optimize transportation routes and minimize the distance travelled by vehicles without any cargo (Kara & Yalçın, 2022). Real-time tracking and monitoring systems can enhance the efficiency and sustainability of logistics operations by identifying areas for improvement in environmental performance (Moldabekova et al., 2021). Utilizing digital marketplaces to connect logistics providers with companies and consumers who are actively seeking environmentally friendly transportation options can facilitate the implementation of green

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logistics practices and the establishment of sustainable logistics infrastructure (Joshi & Sharma, 2022).

Similarly, the adoption of digital technology can improve the environmental performance of logistics operations in developing nations (Mahalakshmi et al., 2019; Hamidu, 2017). It is essential to bear in mind that strong government regulations and the cultivation of skilled professionals, such as ICT specialists, are imperative for the effective incorporation of digital technologies in logistics operations (Huđek et al., 2019; Volkova et al., 2019). These measures facilitate the integration of digital technologies and the sustainable use of internet services (Moldabekova et al., 2021). However, the current body of literature does not provide a specific model that elucidates the impact of ICT specialists and digital technologies on the performance of green logistics. This study aimed to address the existing knowledge gap by examining the impact of digital technologies, such as augmented reality, robots, and predictive analytics, on the performance of green logistics. The study's theoretical framework was built upon the Unified Theory of Acceptance and Use of Technology, the Technology-Organization-Environment model, and the Schumpeter Theory of Innovation.

Literature Review

The Unified Theory of Acceptance and Use of Technology (UTAUT) was employed in this study because it provides a solid framework for understanding the fundamental drivers of technology adoption and application across a range of settings and demographic groups (Venkatesh et al., 2003; Oshlyansky et al., 2007; Morales & Trinidad, 2019). The UTAUT model is criticized for a number of reasons, including problems with its applicability, cultural bias, oversimplification of constructs, lack of dynamic elements, and challenges with measurement (Morales & Trinidad, 2019; Altalhi, 2021; VanDeWiele et al., 2022; Shatta, 2024). In order to successfully manage green logistics performance in a changing business environment and get around the limitations of the UTAUT model, this study integrated the Schumpeter Theory of Innovation (Shatta, 2024). Schumpeter's theory, however, stresses economic development and transformation in capitalist societies rather than just business cycles, which is in contrast to traditional economic analyses (Sweezy, 1943; Upadhyay, 2018; Peng, 2023). In order to overcome the shortcomings of Schumpeter Theory of Innovation, the Technology-Organization-Environment (TOE) model was incorporated into this study (Shatta, 2024). This is because the TOE model considers external environments, including the political, social, and regulatory environments, as well as market and economic conditions (Tornatzky & Fleischer, 1990; Rehman Khan et al., 2022; Shatta, 2024). This study aimed to fill the current knowledge gap by integrating these theories and model in evaluating the effects of digital technologies, specifically augmented reality, predictive analytics, and the intention to use robots, on the performance of green logistics.

Augmented reality has various effects on robots, including improving task performance, navigation, human-robot interaction, learning, collaboration, and signal visualization (Shatta, 2024; Brizzi et al., 2017; Ogata et al., 2022; Enta et al., 2014). Augmented reality (AR) also enables the creation of a common understanding and fair allocation of contributions during problem-solving activities (Radu et al., 2021; Groechel et al.,2021). This study hypothesized that augmented reality (AR) would have a direct impact on the intention to use robots (IUR) and an indirect impact on the performance of green logistics (GLP). Previous studies did not specifically examine the indirect effects of AR on GLP.

Similarly, predictive analytics can be used to detect possible malfunctions or accuracy issues in industrial robots before they happen. This allows for proactive maintenance and reduces unexpected periods of inactivity (Suhane et al., 2020; Borgi et al., 2017). Borgi et al. (2017)

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argue that the use of data-driven predictive maintenance techniques can improve the efficiency and availability of industrial robots. This is achieved by scheduling maintenance activities based on the real-time condition of the robots, rather than following pre-determined schedules (Borgi et al., 2017). Predictive analytics can have a substantial effect on the performance and operation of robots by anticipating their movement patterns and adjusting the control inputs accordingly (Yacoub et al., 2016; Yacoub et al., 2013; Shankar, 2019). In addition, predictive analytics can employ sensor data to anticipate potential malfunctions or maintenance needs, allowing for proactive maintenance and reducing operational disruptions (Shankar, 2019). By integrating predictive analytics into robotic systems, there is the possibility of enhancing efficiency, autonomy, and adaptability. This, in turn, can improve the overall performance and capabilities of robots in a wide range of applications (Shankar, 2019; Yacoub et al., 2016; Yacoub et al., 2013). While prior studies acknowledge the direct influence of predictive analytics (PA) on green logistics performance (GLP), this research suggests that predictive analytics has a direct effect on the intention to use robots (IUR) and an indirect effect on green logistics performance (GLP).

Furthermore, ICT specialists are essential in advancing and improving digital technologies through their expertise and ability to solve complex problems (Huđek et al., 2019; Volkova et al., 2019). To facilitate the integration of information and communication technology (ICT) and enhance the effective use of digital tools, they can employ targeted interventions and offer training programs (Gagnon et al., 2009). Similarly, information and communication technology (ICT) specialists possess the capacity to influence and direct the advancement and expansion of the digital landscape through their efforts and advocacy (Proulx, 2009). Although previous research acknowledges the significance of ICT specialists in improving digital technologies, it has not thoroughly investigated the moderating effects of ICT specialists on the relationships between digital technologies and the performance of green logistics. This study proposed that ICT specialists would play a positive role in enhancing the implementation of digital technologies to improve green logistics performance, with the aim of addressing the current knowledge gap.

In addition, the current literature asserts that robots can improve the environmental sustainability of logistics operations by using different methods that lead to lower energy consumption and waste compared to manual operations (Sen, 2017). Robots can be programmed to improve the efficiency of routes and transportation, leading to decreased fuel consumption and greenhouse gas emissions (Mahalakshmi et al., 2019). The study conducted by Mahalakshmi et al. (2019) emphasizes the importance of utilizing automation, robotics, and smart systems to improve the cleanliness and environmental sustainability of warehouse environments. The study highlights that the use of robots in warehousing operations can contribute to green logistics by reducing the environmental impact of logistics activities, such as lowering CO2 emissions from freight transport and warehousing (Mahalakshmi et al., 2019; Hamidu, 2017). Based on the findings of previous research, this study proposed that the intention to use robots (IUR) would positively influence green logistics performance (GLP). Moreover, this study suggests that the intention to use robots (IUR) plays a beneficial role in the relationships between augmented reality (AR), predictive analytics (PA), and ICT specialists (ICTS) in terms of enhancing green logistics performance.

Conceptual Model of the Study

The conceptual model of this study was formulated by integrating the insights from previous empirical research and the theoretical underpinnings of the study, which draw upon the Unified Theory of Acceptance and Use of Technology, Technology-Organization-Environment model

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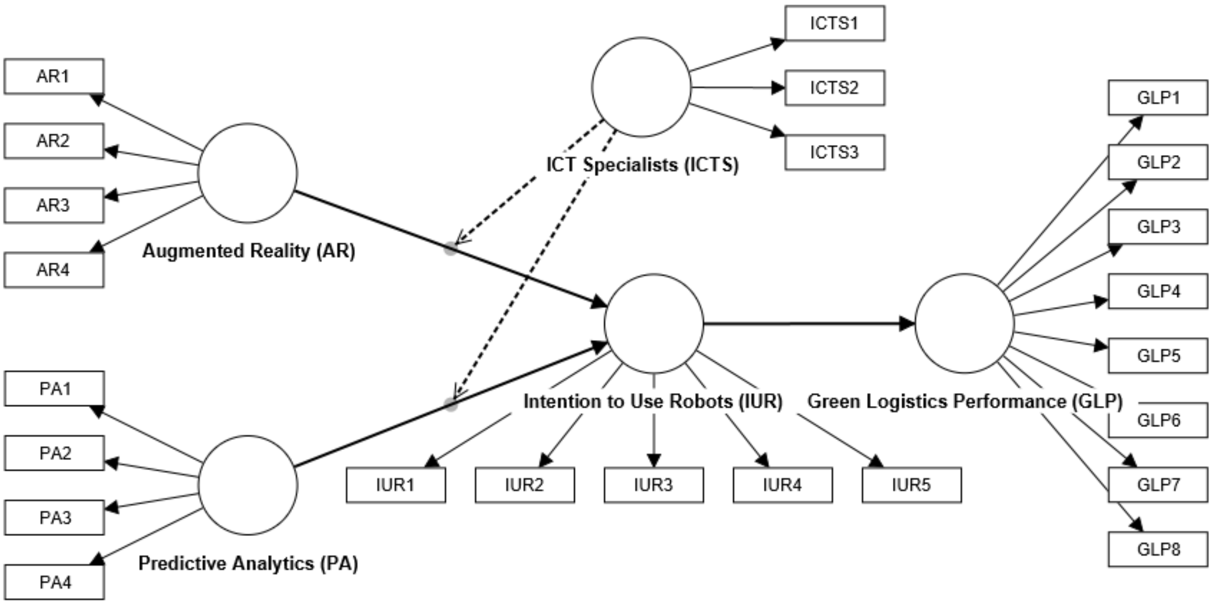
and Schumpeter Theory of Innovation as guiding frameworks. The study's conceptual model is illustrated in Figure 1.

Independent Variables Moderator Variable Dependent Variable



Mediator Variable

Key

-------------▶ Empirical and Theoretical Gaps

Source: Authors

Figure 1. Study's Conceptual Model

The Mathematical Model of the Study

Figure 1 illustrates how the study used the mathematical formula x = lY + e to show the relationships between latent variables and their obvious indicators. The variables x and Y represent the observable indicator and the hidden variable, respectively. The loading coefficient (l) is a statistical metric that measures the correlation between the latent independent variable Y and the observable dependent indicator x. The variable e represents stochastic measurement error (Sarstedt et al., 2022; Shatta, 2023; Shatta & Mabina, 2024a; Shatta & Mabina 2024b; Shatta et al., 2024).

Methods

The adoption of post-positivist philosophy arose from the necessity to empirically test research hypotheses. Furthermore, the study employed cross-sectional survey research methods that were both descriptive and explanatory to gather data from a specific sample of suppliers and buyers from procuring entities located in Tanzania. This is due to the limited data collection and the study's focus on a specific subset of the population (Creswell & Plano, 2018). Similarly, this study gathered data via surveys and employed both descriptive and inferential statistics to quantitatively analyze it. However, this study used the tenth rule proposed by Hair et al. (2019) to determine the appropriate sample size needed to test the hypotheses of the study model using PLS-SEM with the help of SmartPLS 4 software. According to Hair et al. (2019), the tenth rule of thumb states that the minimum sample size required to test the hypotheses of a specific research model is ten times the maximum number of indicators of the exogenous construct.

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The sample size of 427 respondents was sufficient to evaluate the study's hypotheses, as it exceeded the minimum of the sample size required. Moreover, closed-ended questionnaires were assigned numerical values to improve the accuracy and effectiveness of processing quantitative data. The quantitative data collected for the respondents' profiles was analyzed using the descriptive statistics with the assistance of IBM SPSS Statistics Software Version 26. The SmartPLS 4 application effectively handled missing data by employing the extra response technique. In this study, any missing values identified in the surveys were substituted with the numerical value 99.

Models Assessment

In this study, a reflective model was selected because each indicator relied on its corresponding constructs (Hair et al., 2019). Furthermore, the proposed study model's measurement and structural models were assessed based on the criteria established by Hair et al. (2019). Assessing the reflective measurement model necessitated a complex series of steps. Initially, the reliability of the indicators was evaluated, and a threshold of 0.708 or higher was deemed necessary. Furthermore, a threshold higher than 0.708 was employed to assess the internal consistency reliability of the composite reliability of constructs. Additionally, the Average Variance Extracted (AVE) value, which was required to exceed 0.5, was utilized to evaluate the convergent validity of the constructs. The discriminant validity was determined using the Heterotrait-Monotrait Ratio of Correlations (HTMT) criteria, which required a value below 0.9. Moreover, the correlation between the constructs in the structural model was assessed. Hair et al. (2019) assert that VIF values should not exceed five. The main variables utilized in PLS-SEM to evaluate the structural model, accounting for collinearity, were as follows. If the t-statistic for each path exceeds 1.96 at a significance level of 0.05, then path coefficients that meet the significance level are considered acceptable, and p-values of 0.05 or lower are considered statistically significant (Hair et al., 2019). As stated by Hair et al. (2019), R^2 values of 0.75, 0.50, and 0.25 are considered to represent moderate, weak, and significant levels of correlation, respectively. In a similar vein, Hair and his colleagues (2019) found that effect sizes (f^2) greater than 0.02, 0.15, and 0.35 indicate small, moderate, and large impact sizes, respectively. In general, the assessment results for the structural and measurement models were positive and met all the requirements specified by Hair et al. (2019).

Result and Discussion

The following sections explain and discuss the results of the study.

Demographic Characteristics of the Respondents

Table 1 presents the information regarding the gender, age group, degree of education, and experience of the respondents. The male respondents constituted approximately fifty-eight percent, while the female respondents constituted approximately forty-two percent. Furthermore, a significant majority of the participants, specifically eighty-four percent, fell within the age group of thirty to fifty. Furthermore, approximately fifty-nine percent of the respondents possessed a bachelor's or master's degree. However, a significant majority of participants, specifically sixty eight percent, possessed a range of one to ten years' worth of prior experience with the public procurement process, either as suppliers or buyers. These findings indicate that the collected information was precise.

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Table 1: Demographic Characteristics of the Respondents (n=427)

Characteristics		**Frequency**	**Percentage (%)**
Sex	Male	247	57.8
	Female	180	42.2
Age Group	21-30	18	4.2
	31-40	206	48.2
	41-50	153	35.8
	51-60	34	8.0
	61+	16	3.8
	Secondary Education	49	11.5
Education	Certificate Level	56	13.1
	Diploma Level	72	16.9
	Bachelor Degree	182	42.6
	Master's Degree	68	15.9
Experience	1-10	291	68.2
	11-20	115	26.9
	21-30	17	4.0
	31+	4	0.9

Indicator's Reliabilities, R^2 Values and Relevance of the Path Coefficients

Upon employing the PLS-SEM algorithm using SmartPLS 4 software, it was determined that the loadings of all indicators for the constructs exceeded the suggested threshold of 0.708, as proposed by Hair et al. (2019). The R^2 values of 0.541 and 0.608 suggest that the exogenous variables, namely Augmented Reality (AR), Predictive Analytics (PA), and ICT Specialists (ICTS), can explain around 54.1 percent of the variability in Intention to Use Robots (IUR). Moreover, the study found that a considerable percentage (60.8 percent) of the variation in Green Logistics Performance (GLP) can be attributed to the collective influence of Augmented Reality (AR) and Predictive Analytics (PA) as predictors, ICT Specialists (ICTS) as a moderator, with Intention to Use Robots (IUR) serving as a mediator. Moreover, all proposed influences exhibited positive path coefficients, suggesting that a one-standard deviation rise in the exogenous constructs (Augmented Reality (AR), Predictive Analytics (PA), and ICT Specialists (ICTS), as well as the mediator Intention to Use Robots (IUR), led to an elevation in the level of Green Logistics Performance (GLP). Figure 2 illustrates the reliability of the indicators, the R^2 values, and the relevance of the path coefficients.

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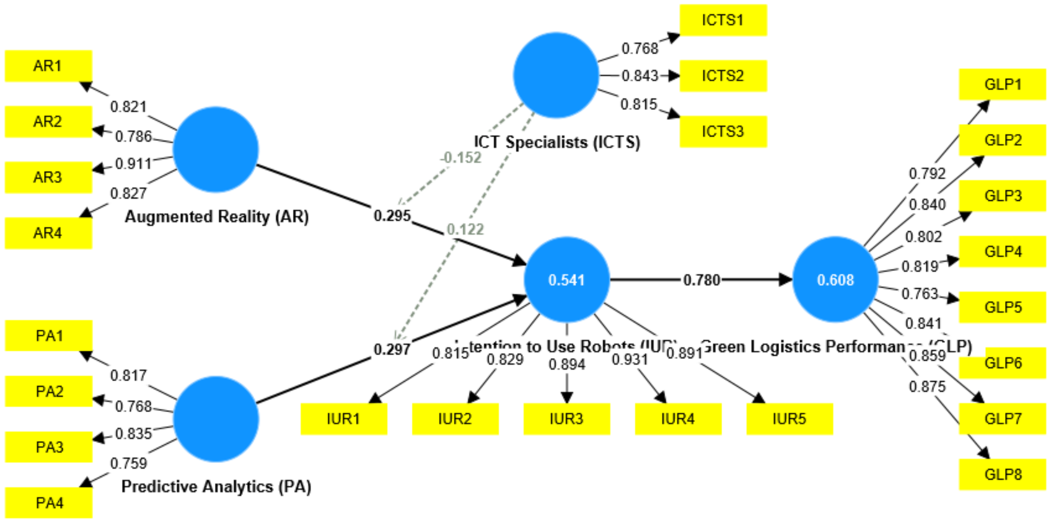

Figure 2. Indicator's Reliabilities, R^2 Values and Relevance of the Path Coefficients

Reliability and Convergent Validity Analysis Results

Based on the research conducted by Hair et al. (2019), a construct is deemed reliable if its composite reliability (CR) score is higher than 0.708. In addition, in order for a construct to possess convergent validity, its Average Variance Extracted (AVE) value must exceed 0.5. This study evaluated the reliability of all constructs by measuring their composite reliability (CR) values, which were determined to be higher than 0.708. In addition, the convergent validity of all constructs was assessed using the Average Variance Extracted (AVE) value, which exceeded 0.5. The results indicate that this study identified positive response patterns, with each component contributing to explaining the variation in its corresponding item (Hair et al., 2019). Table 2 displays the reliability and validity of the constructs used in the study.

Table 2. The Reliability and Validity Values of the Constructs

Construct	Composite Reliability	Average Variance Extracted
Augmented Reality (AR)	0.904	0.702
Green Logistics Performance (GLP)	0.944	0.680
ICT Specialists (ICTS)	0.850	0.654
Intention to Use Robots (IUR)	0.941	0.763
Predictive Analytics (PA)	0.873	0.633

Discriminant Validity Analysis (HTMT Results)

Table 3 shows that all of the influences examined in the research model had HTMT values less than 0.90. The findings indicate that each component in the study model was empirically distinct from the other components in the structural model, as proposed by Hair et al. (2019).

Table 3. Discriminant Validity Analysis (HTMT Results)

Construct	Augmented Reality (AR)	Green Logistics Performance (GLP)	ICT Specialists (ICTS)	Intention to Use Robots (IUR)	Predictive Analytics (PA)
Augmented Reality (AR)	0.838				
Green Logistics	0.532	0.825			

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Performance (GLP)					
ICT Specialists (ICTS)	0.541	0.648	0.809		
Intention to Use Robots (IUR)	0.617	0.780	0.600	0.873	
Predictive Analytics (PA)	0.569	0.587	0.697	0.630	0.795

Collinearity Statistics by VIF Metric for Inner Model

The Variance Inflation Factor (VIF) was used to analyze collinearity data. However, Hair et al. (2019) discovered that VIF values less than 5 indicate that the proposed research model's predictor constructs are free of collinearity problems. Table 4 displays the statistical results for collinearity in the inner model of the recommended study model. The VIF metric was used, and values less than 4 indicate that the predictor structures were free of collinearity.

Table 4. Collinearity Statistics (VIF) for Inner Model

Construct	Green Logistics Performance (GLP)	Intention to Use Robots (IUR)
Augmented Reality (AR)		1.722
ICT Specialists (ICTS)		2.078
Intention to Use Robots (IUR)	1.000	
Predictive Analytics (PA)		2.273
ICT Specialists (ICTS) x Augmented Reality (AR)		3.095
ICT Specialists (ICTS) x Predictive Analytics (PA)		3.022

F^2 Values Results

Impact sizes of 0.02, 0.15, and 0.35 are classified as small, medium, and large f^2 values, respectively, based on the research conducted by Hair et al. (2019). Table 5 displays the effect sizes (f^2) that were found during the study's analysis for each unique connection: 0.034, 0.046, 0.051, 0.085, 0.110, and 1.551. These figures show that all of the hypotheses in the research model have small and large effect sizes, respectively.

Table 5. F^2 Values Results

Construct	Green Logistics Performance (GLP)	Intention to Use Robots (IUR)
Augmented Reality (AR)		0.110
ICT Specialists (ICTS)		0.051
Intention to Use Robots (IUR)	1.551	
Predictive Analytics (PA)		0.085
ICT Specialists (ICTS) x Augmented Reality (AR)		0.046
ICT Specialists (ICTS) x Predictive Analytics (PA)		0.034

Statistical Significance Results for the Hypothesized Relationships

Bootstrapping from SmartPLS 4 validated all suggested relationships with p-values < 0.05, indicating that this study's conceptual research model is appropriate for management decision-

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making regarding the impact of digital technologies on green logistics performance. These phenomena provide evidence for the existence of all hypothesized relationships. Figure 3 displays the statistical significance results for the hypotheses.

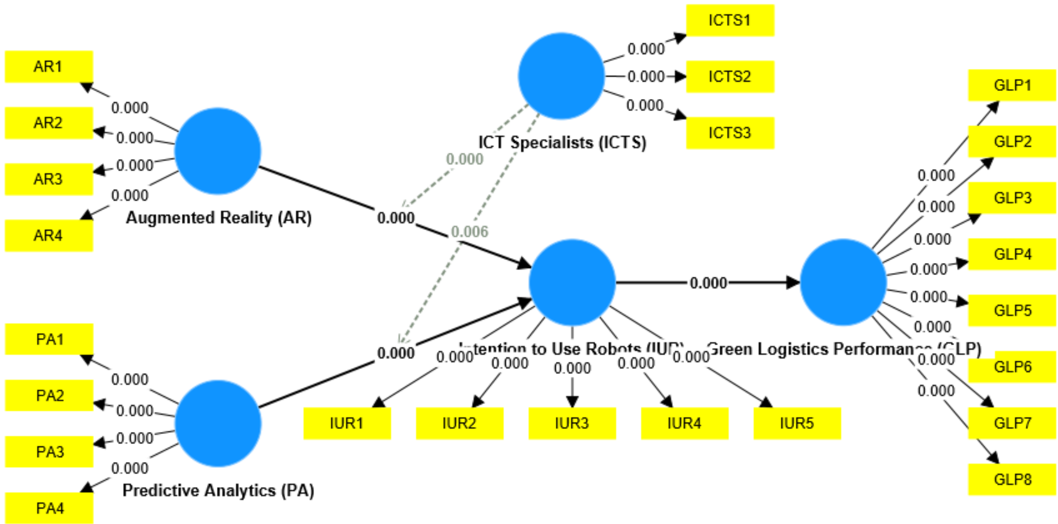

Figure 3. Statistical Significance of the Hypothesized Relationships

Indirect Statistical Significance Results

Table 6 summarizes the results of evaluating the indirect assumptions derived from the study's theoretical framework. The bootstrapping report using SmartPLS 4 software produced statistically significant results for all indirect predictions (p-values <0.05). This suggests that the model's constructs, particularly the mediator and moderator, have real-world connections, and that the validated model can be effectively used to make decisions about the variables influencing the performance of green logistics, particularly the interactions between digital technologies and ICT Specialists.

Table 6. Indirect Statistical Significance Results

Hypothesis	Effect	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P values
ICTS ->IUR -> GLP	Indirect	0.040	4.299	0.000
ICTS x AR -> IUR -> GLP	Indirect	0.033	3.618	0.000
ICTS x PA -> IUR -> GLP	Indirect	0.035	2.695	0.007
PA -> IUR -> GLP	Indirect	0.042	5.557	0.000
AR -> IUR-> GLP	Indirect	0.049	4.659	0.000

Total Effects of Statistical Significance Results of the Hypotheses

Table 7 summarizes the findings from assessing the overall effects (direct and indirect assumptions) using the study's theoretical framework. After creating a bootstrapping report with SmartPLS 4, the total effects of the predictions were found to be statistically significant (p values < 0.05). This implies that the connections observed in the model are present in real-world situations, and that the validated model can be effectively applied to decision-making about green logistics performance.

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Table 7. Total Effects of Statistical Significance Results of the Hypotheses

Hypothesis	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P values
AR -> GLP	0.049	4.659	0.000
AR -> IUR	0.059	5.014	0.000
ICTS -> GLP	0.040	4.299	0.000
ICTS -> IUR	0.051	4.336	0.000
IUR -> GLP	0.025	30.691	0.000
PA -> GLP	0.042	5.557	0.000
PA -> IUR	0.056	5.293	0.000
ICTS x AR -> GLP	0.033	3.618	0.000
ICTS x AR -> IUR	0.041	3.711	0.000
ICTS x PA -> GLP	0.035	2.695	0.007
ICTS x PA -> IUR	0.045	2.734	0.006

Importance-Performance Map Analysis Results

According to Figure 4, intention to use robots (IUR) is the most important and best option for implementing green logistics performance (GLP) due to its position in the first quadrant. As a result, implementing intention to use robots (IUR) requires additional attention and resources to ensure long-term green logistics performance. However, due to their position in the second quadrant, augmented reality (AR), predictive analytics (PA), and ICT specialists (ICTS) are rated as less important in implementing green logistics performance (GLP). This means that these constructs have little impact on the target construct, green logistics performance. When implementing green logistics performance (GLP), these constructs are also important because they are above average on the performance map of the main focus construct, green logistics performance (GLP).

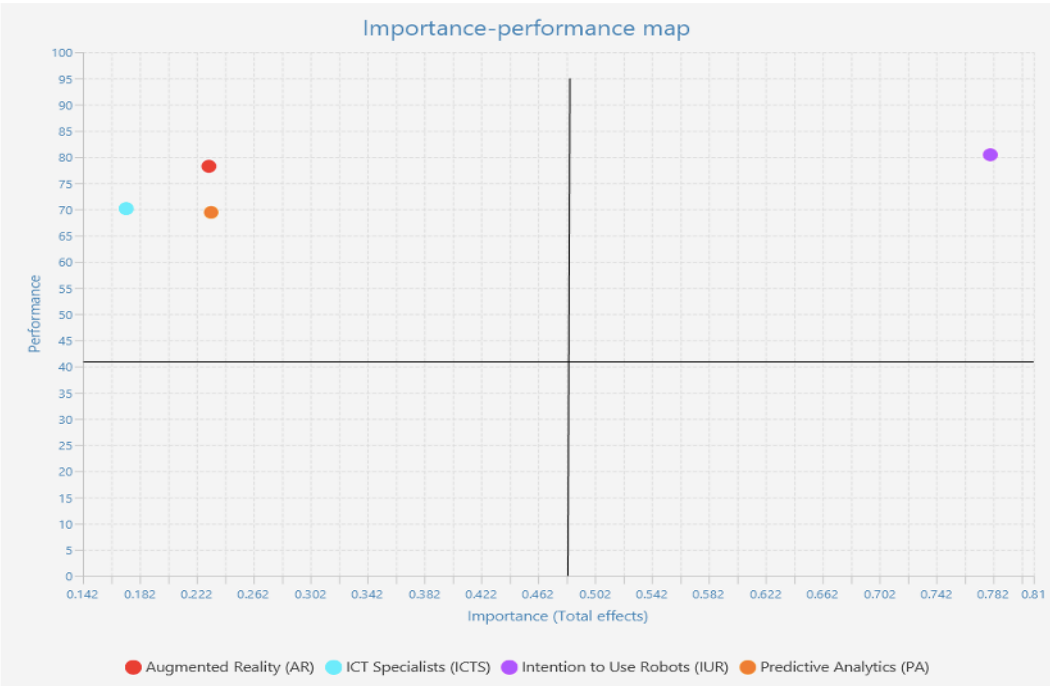

Figure 4. Importance-Performance Map Analysis Results

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The Hypotheses Tested

The study's first idea was that the augmented reality (AR) would have a positive and direct effect on intention to use robots (IUR) and an indirect effect on the green logistics performance (GLP). Figure 2 shows that there were path coefficients that were positive. This means that an increase of one standard deviation in the augmented reality (AR) caused both intentions to use robots (IUR) and green logistics performance (GLP) to go up, and the other way around too. The results in Table 7 also showed that there were statistically significant direct and indirect effects at a level below 0.05 (p value <0.05). Indeed, these results show that the expected relationships do exist in real life. Furthermore, these results support what other studies have found (Brizzi et al., 2017; Ogata et al., 2022; Ogata et al., 2022; Enta et al., 2014; Enta et al., 2014; Radu et al., 2021; Groechel et al., 2021) that the augmented reality (AR) is a key part of achieving green logistics performance (GLP).

This research also predicted that predictive analytics (PA), would have a positive and direct effect on intention to use robots (IUR), and it would also have an indirect effect on green logistics performance (GLP). Figure 2 showed that there were positive path coefficients. This meant that if predictive analytics (PA) went up by one standard deviation, intention to use robots (IUR) and green logistics performance (GLP) would get better, and the other way around. As shown in Table 7, the study's results show that predictive analytics (PA) has a positive and statistically significant effect on both intentions to use robots (IUR) and the green logistics performance (GLP). This study's results agree with those of earlier ones (Shankar, 2019; Yacoub et al., 2016; Yacoub et al., 2013; Suhane et al., 2020; Borgi et al., 2017). These studies show that predictive analytics (PA) technology is very important for improving the green logistics performance (GLP).

Similarly, the study thought that intention to use robots (IUR) would have a direct and positive effect on the green logistics performance (GLP) and would act as a mediator between the augmented reality (AR), predictive analytics (PA), and the ICT specialists (ICTS).The results in Figure 2 support a positive path coefficient, which means that a one-standard deviation rise in intention to use robots (IUR) will result in an improvement in the green logistics performance (GLP), and the other way around. Additionally, Table 7 show that intention to use robots (IUR) has a significant positive effect on green logistics performance (GLP) and acts as a positive mediator between the augmented reality (AR), predictive analytics (PA), and the ICT specialists (ICTS). Previous studies ((Sen, 2017; Mahalakshmi et al., 2019; Hamidu, 2017) have shown that intention to use robots (IUR) is a key part of improving green logistics performance (GLP).

Above all, this study hypothesized that the ICT specialists (ICTS) would directly and positively affect the connections between the augmented reality (AR), and intention to use robots (IUR). In the same way, the study thought that the ICT specialists (ICTS) would directly and positively affect the connections between predictive analytics (PA) and intention to use robots (IUR). The findings in Figure 2 support both a positive and negative path coefficient. They show that if the ICT specialists (ICTS) got better by one standard deviation, intention to use robots (IUR) would get better too, and the other way around as well. Additionally, Table 6 show that the ICT specialists (ICTS) have a significant positive effect (p value < 0.05) on the connections between the augmented reality (AR) and intention to use robots (IUR), as well as the connections between the predictive analytics (PA) and intention to use robots (IUR). Based on these findings, ICT specialists (ICTS) might be able to help balance this relationship by setting rules and guidelines for how digital technologies can be used in green logistics, making sure that sustainability standards and practices are followed, and having an impact on how IT

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platforms are designed and put in place. Other studies (Huđek et al., 2019; Volkova et al., 2019; Gagnon et al., 2009; Proulx, 2009) have found different results. These earlier studies didn't directly look at how ICT specialists (ICTS) affect the relationship between digital technologies and green logistics performance (GLP). They do, however, give us useful information about the importance of ICT specialists (ICTS) in adopting digital technologies. The following sections explain the conclusion and suggestions of the study.

Theoretical Contribution

With ICT Specialists (ICTS) serving as moderators, this study effectively addressed the need for a specific model that defines the factors influencing the performance of green logistics. The existing body of theoretical and empirical literature lacks this paradigm. The technology-organization-environment model, the Schumpeter Theory of Innovation, and the Unified Theory of Acceptance and Use of Technology were all used in this study; however, as of yet, none of these models have a clear framework that fully understands the role of a moderator and mediator in achieving green logistics performance (GLP). A validated model explaining the role of a moderator and mediator in achieving green logistics performance (GLP) is shown in Figure 5.

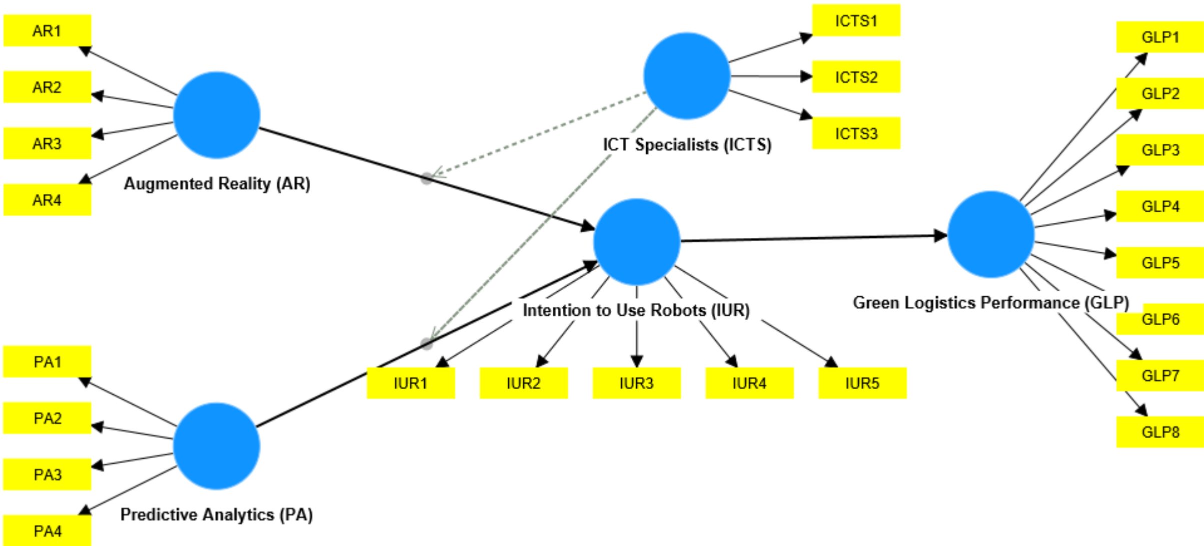

Figure 5: Validated model.

Key

-----------➤ Empirical and Theoretical Contribution

Social Implications

Figure 5 shows that the intention to use robots (IUR) acts as a bridge between ICT Specialists (ICTS), other digital technologies (such as Augmented Reality (AR) and Predictive Analytics (PA)) and green logistics performance (GLP). These results show how important intention to use robots (IUR) is for making green logistics more sustainable in the long term. In the same way, the statistical position of ICT Specialists (ICTS) in relation to direct and indirect effects shows that these factors are always important for integrating digital technologies and making green logistics more sustainable.

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Conclusion

The findings in Figure 4 strongly suggest that the suggested study model is the best way to make choices, especially when deciding how to spend money on Intention to Use Robots (IUR) and Green Logistics Performance. To figure out how to predict the rise in green logistics performance (GLP) with a few digital technologies, this study used a quantitative method and a cross-sectional survey design. As shown in Figure 2, using these digital technologies along with ICT specialists as a moderator only accounted for 60.8 percent of the variances in green logistics performance. According to this study, more research should look at a mixed approach that includes digital technologies like Blockchain (BC), Artificial Intelligence (AI), and the Internet of Things (IoT). This method should be used to make green logistics performance (GLP) more variable and to make the validated model more useful in more situations. Also, the study only included people from Tanzania. Respondents from more than one country should be included in future studies to make the validated model more useful for predicting the factors that affect green logistics performance (GLP).

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References

Altalhi, M. M. (2021). Towards understanding the students' acceptance of MOOCs: A unified theory of acceptance and use of technology (UTAUT). *International Journal of Emerging Technologies in Learning (iJET)*, *16*(2), 237-253.

Bogue, R. (2016). Growth in e-commerce boosts innovation in the warehouse robot market. *Industrial Robot: An International Journal*, *43*(6), 583-587.

Borgi, T., Hidri, A., Neef, B., & Naceur, M.S. (2017). Data analytics for predictive maintenance of industrial robots. *2017 International Conference on Advanced Systems and Electric Technologies (IC_ASET)*, 412-417.

Brizzi, F., Peppoloni, L., Graziano, A., Di Stefano, E., Avizzano, C. A., & Ruffaldi, E. (2017). Effects of augmented reality on the performance of teleoperated industrial assembly tasks in a robotic embodiment. *IEEE Transactions on Human-Machine Systems*, *48*(2), 197-206.

Creswell, J. W, & Plano, C. V. L. (2018). Designing and conducting mixed methods research. Thousand Oaks, CA: Sage.

Ehrenmüller, I., Hasenauer, R., & Belviso, C. (2019, August). Social assistive robots for elderly care: the new efficiency in the context of triple bottom line and digitization. In *2019 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1-14). IEEE.

Enta, A., Hayashida, K., Yoshioka, Y., Sano, T., Takahashi, M., & Watanabe, H. (2014). Effects of Spatial Variables on Correlation Between Human and Interactive Robot Presented with Augmented Reality Technology. *Journal of Architecture and Planning (transactions of Aij), 79*, 329-337.

Esmaeilian, B., Behdad, S., & Wang, B. (2016). The evolution and future of manufacturing: A review. *Journal of manufacturing systems*, *39*, 79-100.

Copyright © 2024, International Journal Papier Public Review, Under the license CC BY-SA 4.0
DOI: https://doi.org/10.47667/ijppr.v5i4.317

Faber, N., De Koster, M. B. M., & Smidts, A. (2013). Organizing warehouse management. *International Journal of Operations & Production Management*, *33*(9), 1230-1256.

Fan, M., Wu, Z., Qalati, S. A., He, D., & Hussain, R. Y. (2022). Impact of green logistics performance on China's export trade to regional comprehensive economic partnership countries. *Frontiers in Environmental Science*, *10*, 879590.

Gagnon, M. P., Légaré, F., Labrecque, M., Frémont, P., Pluye, P., Gagnon, J., & Gravel, K. (2009). Interventions for promoting information and communication technologies adoption in healthcare professionals. *Cochrane database of systematic reviews*, (1).

Groechel, T. R., O'Connell, A., Nigro, M., & Matarić, M. J. (2022, August). Reimagining rviz: Multidimensional augmented reality robot signal design. In *2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)* (pp. 1224-1231). IEEE.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review, 31(1),* 2-24.

Hamidu, M. (2017, March). Deducing of an automobile design for an electric vehicle (EV): perspective of technological acceptance model (TAM). In *International Conference on Applied Science and Technology Conference Proceedings* (Vol. 3, No. 1, pp. 11-24).

Huđek, I., Širec, K., & Tominc, P. (2019). Digital skills in enterprises according to the European digital entrepreneurship sub-indices: Cross-country empirical evidence. *Management: Journal of Contemporary Management Issues*, *24*(2), 107-119.

Joshi, S., & Sharma, M. (2022). Digital technologies (DT) adoption in agri-food supply chains amidst COVID-19: an approach towards food security concerns in developing countries. *Journal of Global Operations and Strategic Sourcing*, *15*(2), 262-282.

Kara, K., & Yalçın, G. C. (2022). Digital Logistics Market Performance of Developing Countries. *Uluslararası Akademik Birikim Dergisi*, *5*(5).

Mahalakshmi, S., Arokiasamy, A., & Ahamed, J. F. A. (2019). Productivity improvement of an eco friendly warehouse using multi objective optimal robot trajectory planning. *International Journal of Productivity and Quality Management*, *27*(3), 305-328.

Moldabekova, A., Philipp, R., Reimers, H. E., & Alikozhayev, B. (2021). Digital technologies for improving logistics performance of countries. *Transport and Telecommunication Journal*, *22*(2), 207-216.

Moldabekova, A., Philipp, R., Reimers, H. E., & Alikozhayev, B. (2021). Digital technologies for improving logistics performance of countries. *Transport and Telecommunication Journal*, *22*(2), 207-216.

Morales, D. T., & Trinidad, F. L. (2019). Unified Theory of Acceptance Use of Technology (UTAUT) and its Applicability to Mortgage Banking Digitization: The case of the philippines. *Journal of Information System and Technology Management*, *4*(14), 47-60.

Copyright © 2024, International Journal Papier Public Review, Under the license CC BY-SA 4.0
DOI: https://doi.org/10.47667/ijppr.v5i4.317

Volume 5, Issue 4 (Page 001-016)
ISSN: 2709-023X

Mwanza, B. G., & Mbohwa, C. (2017). Drivers to sustainable plastic solid waste recycling: a review. *Procedia Manufacturing*, *8*, 649-656.

Naranjo-Ávalos, H., Buele, J., Castillo, F., Torres, B., & Salazar, F. W. (2021). Impact of the multiplatform mobile applications and their technological acceptance model in tourist georeferenced management. In *Information Technology and Systems: ICITS 2021, Volume 1* (pp. 313-322). Springer International Publishing.

Ogata, M., Inoue, M., Izumi, K., & Tsujimura, T. (2022). Effects of Augmented Reality Markers for Networked Robot Navigation. In *Advances in Intelligent Networking and Collaborative Systems: The 13th International Conference on Intelligent Networking and Collaborative Systems (INCoS-2021) 13* (pp. 11-22). Springer International Publishing.

Oshlyansky, L., Cairns, P., & Thimbleby, H. (2007, September). Validating the Unified Theory of Acceptance and Use of Technology (UTAUT) tool cross-culturally. In *Proceedings of HCI 2007 The 21st British HCI Group Annual Conference University of Lancaster, UK*. BCS Learning & Development.

Peng, Y. (2023). An Analysis of Entrepreneurial Leadership Based on Schumpeter's Theory of Innovation. *Academic Journal of Business & Management*, *5*(8), 34-37.

Proulx, S. (2009). Can the use of digital media favour citizen involvement? *Global Media and Communication*, *5*(3), 293-307.

Qader, K. S., Jamil, D. A., Sabah, K. K., Anwer, S. A., Mohammad, A. J., Gardi, B., & Abdulrahman, B. S. (2022). The impact of Technological acceptance model (TAM) outcome on implementing accounting software. *International Journal of Engineering, Business and Management*, *6*(6), 14-24.

Radu, I., Hv, V., & Schneider, B. (2021). Unequal impacts of augmented reality on learning and collaboration during robot programming with peers. *Proceedings of the ACM on Human-Computer Interaction*, *4*(CSCW3), 1-23.

Sen, D. K. (2017). *Analysis of Decision Support Systems of Industrial Relevance: Application Potential of Fuzzy and Grey Set Theories* (Doctoral dissertation).

Shahzad, F., Du, J., Khan, I., & Wang, J. (2022). Decoupling institutional pressure on green supply chain management efforts to boost organizational performance: moderating impact of big data analytics capabilities. *Frontiers in Environmental Science*, *10*.

Shankar, V. (2019). Big data and analytics in retailing. *NIM Marketing Intelligence Review*, *11*(1), 36-40.

Shatta, D. N. (2023). Determinants of Behavioral Intention to Use E-Procurement System in Developing Countries: Suppliers' Perception from Tanzania. In State of the Art in Partial Least Squares Structural Equation Modeling (PLS-SEM) Methodological Extensions and Applications in the Social Sciences and Beyond (pp. 537-555). Cham: Springer International Publishing.

Shatta, D. N. (2024). The Influence of Digital Technologies on Sustainable Supply Chain Performance in Public Procuring Entities: A Moderating Effect of Legal Frameworks. *International Journal of Social Science Research and Review*, *7*(6), 43-57.

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DOI: https://doi.org/10.47667/ijppr.v5i4.317

Volume 5, Issue 4 (Page 001-016)
ISSN: 2709-023X

Shatta, D. N., Mabina, B. K., & Myamba, B. (2024). The Effects of E-Procurement Tools on Supply Chain Performance of Procuring Entities in Tanzania: Mediation Effect of Behavioral Intention. *International Journal of Social Science Research and Review*, *7*(7), 98-118.

Shatta, D., & Mabina, B. (2024a). Theorized model for e-procurement system in developing countries: evidence from Tanzania. *International Journal of Research in Business and Social Science (2147-4478)*, *13*(2), 420-434.

Shatta, D., & Mabina, B. (2024b). The determinants of use behavior of e-procurement system in developing countries: a mediating effect of buyers' and suppliers' attitude from Tanzania. *International Journal of Business Ecosystem & Strategy (2687-2293)*, *6*(2), 151-165.

Shi, Z., Jiang, H., & Jiao, S. (2023, May). Research on the Impact of Big Data Resources on the Digital Transformation Performance of Manufacturing Enterprises. In *2023 IEEE 3rd International Conference on Information Technology, Big Data and Artificial Intelligence (ICIBA)* (Vol. 3, pp. 206-211). IEEE.

Suhane, S., Patil, P. D., Mishra, R., Koul, S., Shukla, R., & Rao, J. (2020). Robolution: Real Time Predictive Analytics for Industrial Robots. *International Journal of Engineering and Advanced Technology*, *9*(3), 923-926.

Sweezy, P. M. (1943). Professor Schumpeter's theory of innovation. *The Review of Economics and Statistics*, *25*(1), 93-96.

Tarhini, A., Arachchilage, N.A., Masa'deh, R., & Abbasi, M.S. (2015). A Critical Review of Theories and Models of Technology Adoption and Acceptance in Information System Research. *Int. J. Technol. Diffusion, 6*, 58-77.

Tornatzky, L. & Fleischer, M. (1990). *The process of technology innovation*, Lexington, MA, Lexington Books

Upadhyay, S. (2018). A Critical Study of Joseph A. Schumpeter's Innovation Theory of Entrepreneurship.

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). Users' Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly, 27(3),* 287-294.

Volkova, V., Leonova, A., Loginova, A., & Chernyy, Y. (2019, October). System analysis of the development of information-communication technologies. In *Proceedings of the XI International Scientific Conference Communicative Strategies of the Information Society* (pp. 1-6).

Yacoub, M. I., Necsulescu, D. S., & Sasiadek, J. Z. (2013, June). Experimental evaluation of energy optimization algorithm for mobile robots in three-dimension motion using predictive control. In *21St Mediterranean Conference on Control and Automation* (pp. 437-443). IEEE.

Yacoub, M. I., Necsulescu, D. S., & Sasiadek, J. Z. (2016). Energy consumption optimization for mobile robots' motion using predictive control. *Journal of Intelligent & Robotic Systems*, *83*, 585-602.

Zhao, X., & Yan, D. (2023). Incorporating technological acceptance model into safety compliance of construction workers in Australia. *Safety sc*

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DOI: https://doi.org/10.47667/ijppr.v5i4.317