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Principal's message

The number of our Master's students continues to rise, with over 1,700 now. The impact on ICL's research activity has been significant, with all these students submitting either an Applied Project or increasingly, a thesis: at present over 360 of our postgraduates are taking a Master's by Thesis.

In this edition we have six papers covering a range of specialist areas: perhaps it is inevitable that we have a paper on AI, but it is surprising that it should focus away from the mainstream, on New Zealand's remote tertiary education. We present three papers on green issues, again off the beaten track: on the carbon footprint of online shopping, on the impact of foreign investment on carbon emissions, and on green training and innovation. And finally, we present two more traditional essays, on online banking customer satisfaction and how informatics can improve retail. As usual it's a rich and varied mix.

We thank our research advisory board members, led by Professor Ron Newman in his 18th year on the board, for their wise counsel, and Dr Paula Ray and her team of research-led lecturers for their ongoing passion and engagement.

Next year we plan to peer review all our journal papers, and this will mark another grand development in the history of ICL Graduate Business School.

Ewen Mackenzie-Bowie
Principal and Director
ICL Education Group

December 2025

Analysis of the Impact of AI and Metaverse Integration in New Zealand's Remote Tertiary Education

Gamage Sharmila Iroshi Perera, Premalatha Sampath and Justin Joseph

ABSTRACT
This study explored students' perceptions of Artificial Intelligence (AI) and Metaverse technologies in online learning platforms within New Zealand's tertiary education sector. Although these technologies are still emerging locally, they are widely recognised for their potential to enhance online learning through intelligent, immersive, and interactive features. The research integrated constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) to examine how perceived ease of use, perceived usefulness, motivation, facilitating conditions, and performance expectancy influence student learning engagement. A mono-quantitative approach was adopted using an online questionnaire administered to NZ tertiary students. Data were analysed using descriptive statistics, reliability testing, correlation, and regression analysis. Perceived usefulness, motivation, and facilitating conditions were significant predictors of learning engagement, while perceived ease of use and performance expectancy were not. Student engagement is primarily driven by intrinsic motivation, institutional support, and the perceived value of immersive digital features, highlighting the need for learner-centred design in advanced online learning platforms.

Keywords: *Artificial Intelligence (AI) in Education, Metaverse in Higher Education, Digital Learning Technologies, Immersive Learning Environments, Adaptive and Personalised Learning*

1. INTRODUCTION

The COVID-19 pandemic caused unprecedented disruption to global higher education, compelling institutions to rapidly transition to digital learning modalities. In New Zealand (NZ), tertiary providers adopted video conferencing, pre-recorded lectures, and Learning Management Systems (LMSs) such as Moodle and Blackboard to ensure continuity of education (Clarke & Munro, 2021). Although effective as emergency responses, these approaches largely replicated traditional classroom practices and failed to fully exploit the pedagogical potential of digital learning, which has since become a permanent feature of tertiary education (Al Nabhani et al., 2025).

The abrupt shift to online learning exposed several limitations of existing digital platforms, including reduced social interaction, screen fatigue, and limited opportunities for collaborative and practice-based learning (Tamuli, 2023). These challenges highlighted the inadequacy of conventional LMSs and basic video conferencing tools in delivering engaging and immersive learning experiences, particularly in disciplines requiring experiential learning.

Currently, NZ's tertiary education sector operates through a combination of face-to-face, hybrid, and fully online delivery models. While platforms such as Canvas, Blackboard, Zoom, and Microsoft Teams support flexibility and accessibility, they often struggle to replicate the interpersonal and experiential elements of physical classrooms (Samarasinghe et al., 2025). As a result, there is growing interest in advanced digital technologies that can enhance engagement and learning quality.

1.2 Emergence of AI and Metaverse Technologies in Education

Artificial Intelligence (AI) and Metaverse technologies represent a significant evolution in digital education. AI enables adaptive learning through intelligent tutoring systems, personalised feedback, and real-time progress monitoring, allowing learning experiences to be tailored to individual student needs (Tuczyński, 2024). The Metaverse extends traditional online platforms into immersive three-dimensional (3D) virtual environments, where learners interact through avatars and participate in shared, interactive spaces that simulate real-world learning contexts (Pradana & Elisa, 2023).

Globally, these technologies are increasingly explored to enhance engagement, collaboration, and experiential learning (Maghaydah et al., 2024). In NZ, early pilot initiatives involving virtual classrooms and immersive learning environments demonstrate institutional interest; however, large-scale implementation remains limited (Centre for Innovation and Entrepreneurship, 2022). This highlights the importance of understanding student perceptions before committing to widespread adoption.

1.3 Research Motivation and Purpose

This study is motivated by the permanent shift towards technology-driven education following the COVID-19 pandemic and the growing recognition of the limitations of existing online learning platforms (Clarke & Munro, 2021). While recent research highlights the transformative potential of AI and Metaverse technologies, empirical evidence examining students' perceptions—particularly within the NZ tertiary context—remains limited.

The purpose of this research is to examine students' perceptions of AI- and Metaverse-enhanced remote learning platforms and to assess how these perceptions influence learning engagement. By focusing on perceived usefulness, ease of use, motivation, performance expectancy, and facilitating conditions, the study seeks to provide evidence-based insights to inform the design and adoption of student-centred digital learning environments.

1.4 Research Problem, Objectives, and Questions

Despite ongoing digital transformation in higher education, limited research has explored how students perceive the impact of AI and Metaverse technologies on learning engagement, especially prior to large-scale implementation (Maghaydah et al., 2024). Existing studies often prioritise technical feasibility over learner perspectives, creating a gap between technological potential and effective educational practice. Without empirical evidence guiding adoption, investments in advanced technologies risk failing to meet student needs.

Accordingly, this study aims to:

1. Examine students' perceptions of AI and Metaverse features and their impact on learning engagement.
2. Analyse the influence of motivation derived from immersive Metaverse features on learning engagement.
3. Identify AI and Metaverse features that best support engagement in remote learning environments.

The research addresses the following questions:

1. How do students perceive the impact of AI and Metaverse features on learning engagement?
2. How does motivation influenced by immersive Metaverse features affect learning engagement?
3. Which AI and Metaverse features assist students in maintaining engagement in remote learning?

1.5 Significance of the Study

This study contributes empirical insights into student perceptions of AI and Metaverse integration within NZ tertiary education. The findings inform educators, institutions, and policymakers on how advanced digital technologies can be implemented to enhance engagement, inclusivity, and learning effectiveness. Academically, the research extends existing literature by foregrounding learner perspectives, while practically, it offers guidance for

designing effective, student-centred remote learning environments that support sustainable digital transformation in higher education.

2. LITERATURE REVIEW

2.1 Digital Learning Technologies in Tertiary Education

Rapid technological advancements are transforming higher education, with Artificial Intelligence (AI) and the Metaverse increasingly shaping teaching and learning practices. In New Zealand, tertiary institutions are beginning to explore these technologies to improve engagement, personalisation, and interactivity (Centre for Innovation and Entrepreneurship, 2022). AI is primarily valued for its data-driven intelligence, adaptive learning, and predictive analytics, while the Metaverse offers immersive three-dimensional (3D) environments that support real-time interaction and experiential learning (Almeman et al., 2025). Understanding both the benefits and constraints of these technologies is critical to their effective integration into tertiary education.

2.2 AI- and Metaverse-Enabled Learning Capabilities

2.2.1 Personalised, Adaptive, and Data-Driven Learning

AI enables personalised and adaptive learning by analysing students' behaviour, performance, and preferences to tailor content, difficulty levels, and learning pathways (Villegas-Ch et al., 2020). Through machine learning, recommender systems, and intelligent tutoring, AI dynamically adjusts instruction to sustain engagement and optimise outcomes (Wei et al., 2021; Tuczyński, 2024). Empirical studies indicate that AI-driven personalisation enhances motivation, participation, and academic performance (Al Nabhani et al., 2025).

2.2.2 Intelligent Feedback, Analytics, and Support

AI-powered systems provide immediate, adaptive feedback through continuous monitoring of student performance and engagement (Slimi et al., 2025). Intelligent tutors offer personalised guidance and emotional responsiveness, supporting motivation and self-directed learning (Rane et al., 2023). Learning analytics further enable early identification of performance decline, facilitating timely instructional interventions while reducing instructor workload (Sushama et al., 2022).

2.2.3 Immersive and Collaborative Learning Environments

The Metaverse integrates technologies such as Virtual Reality and Augmented Reality to create immersive, multi-sensory learning environments that enhance

presence and experiential learning (Rane et al., 2023). Students interact via avatars within shared 3D spaces, strengthening collaboration, engagement, and social connection (Muthmainnah et al., 2023). Virtual laboratories enable safe, repeatable practice of complex skills, particularly in healthcare and science education, improving conceptual understanding and independent knowledge construction (Pradana & Elisa, 2023; Al-Muqbil, 2024).

2.3 Comparative Capabilities of Digital Learning Tools

Comparative analysis shows that conventional Learning Management Systems (LMSs) are effective for content delivery and administration but lack adaptability and interactivity. Synchronous communication tools facilitate real-time collaboration yet remain limited to two-dimensional environments. In contrast, AI-driven platforms support adaptive learning and predictive analytics, while Metaverse-integrated systems provide immersive, experiential, and socially rich learning experiences that address key engagement limitations of traditional tools.

2.4 Technology Acceptance and Learning Engagement

The Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) are widely applied frameworks for examining educational technology adoption (Marikyan & Papagiannidis, 2025). TAM focuses on perceived usefulness and ease of use, whereas UTAUT incorporates performance expectancy and facilitating conditions. Both models are flexible and frequently extended for emerging technologies (Venkatesh & Bala, 2008). Integrating motivation enhances their explanatory power, particularly for immersive learning environments (Zhang et al., 2008; Hu & Xiao, 2025).

2.5 Determinants of Learning Engagement

Research consistently identifies perceived usefulness and motivation as strong predictors of sustained engagement with advanced learning technologies (Maghaydah et al., 2024). Facilitating conditions support engagement by ensuring access and technical reliability, although their influence may diminish with increased user experience (Fathema et al., 2015). While perceived ease of use affects initial adoption, its impact on engagement is often mediated by usefulness and self-efficacy (Alalwan et al., 2019).

3. RESEARCH METHODOLOGY

3.1 Research Philosophy

This study adopted a positivist research philosophy, which assumes that knowledge is derived from objective, observable, and measurable phenomena (Saunders et al., 2023). The researcher acted as an independent observer, ensuring that personal beliefs did not influence data collection or interpretation. Students' perceptions of AI- and Metaverse-integrated online learning platforms were captured through structured questionnaires and transformed into quantifiable data. Statistical techniques were then applied to identify relationships between variables and generate generalisable conclusions grounded in established theories.

3.2 Approach to Theory Development

A deductive approach was employed, consistent with positivist philosophy. This approach involved drawing hypotheses from existing theories and testing them using empirical data (Saunders et al., 2023). The study was guided by the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT).

The conceptual model (Figure 1) incorporated performance expectancy and facilitating conditions from UTAUT, and perceived ease of use and perceived usefulness from TAM. In addition, motivation was included as an extended construct to capture intrinsic enjoyment derived from immersive Metaverse features, as supported by prior research (Zhang et al., 2008). Five hypotheses were developed to examine the influence of these variables on perceived learning engagement.

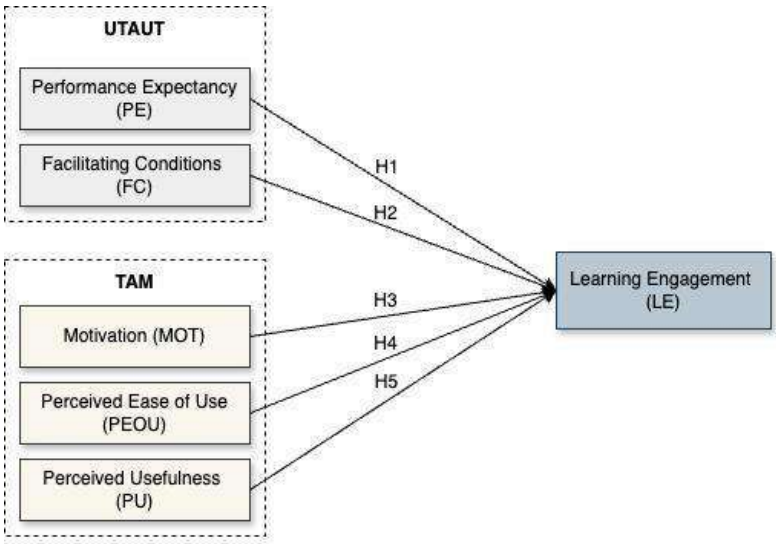

Figure 1: Conceptual Model Diagram (Source: Author)

Following hypotheses were developed and tested using the collected data for relationships between the variables.

H1: Performance expectancy will positively influence perceived learning engagement.
H2: Facilitating conditions will positively influence perceived learning engagement.
H3: Perceived increase in motivation due to immersive Metaverse features will positively influence perceived learning engagement.
H4: Perceived ease of using AI and Metaverse features will positively influence learning engagement.
H5: Perceived usefulness of AI and Metaverse features will positively influence perceived learning engagement.

3.3 Methodological Choice and Research Strategy

This study employed a mono-method quantitative design using a structured questionnaire to measure student perceptions and test hypothesised relationships objectively. A survey strategy was adopted, as it suited the explanatory nature of the research and enabled efficient collection of large-scale perceptual data. The online questionnaire, developed in Google Forms, included 20 Likert-scale items measuring six constructs: performance expectancy, facilitating conditions, motivation, perceived ease of use, perceived usefulness, and learning engagement. Data were collected using a cross-sectional approach over approximately 21 days to capture current student perceptions.

3.4 Research Data, Collection and Analysis

This study used primary quantitative data collected from students enrolled in public and private tertiary institutions in New Zealand to capture current perceptions of AI and Metaverse integration in online learning. A non-probability purposive sampling technique was employed to ensure participants had relevant experience with online learning platforms. Based on an estimated population of 388,840 tertiary students aged over 18, a sample size of 384 was determined to provide adequate statistical power (Education Counts, 2025).

Data were collected through a structured online questionnaire administered via Google Forms and distributed using email, online groups, and QR codes. Responses were securely stored and exported to Excel and IBM SPSS for analysis. Data screening removed incomplete or inconsistent responses. Cronbach's Alpha assessed reliability ($\alpha \geq 0.7$). Descriptive statistics summarised responses, while correlation, regression, cross-tabulation, and ANOVA analyses examined relationships and predictors of learning engagement at a significance level of $p \leq 0.05$.

4. DATA ANALYSIS

4.1 Data Cleansing

356 responses were collected from the online survey and as the first step, the dataset was cleaned and prepared to ensure it is accurate and reliable. Each of the 356 responses that were collected through the online survey was carefully reviewed to ensure the quality and validity of the data. All 356 responses were complete as the survey was designed with mandatory fields for all questions. Responses were checked for any corrupted data or patterns that might indicate superficiality, such as participants selecting the same answer for all Likert scale questions. As no such anomalies were found in the final dataset, all 356 responses were exported to the IBM SPSS software for carrying out the subsequent statistical analyses. This step was crucial as it helped to make reliable conclusions

4.2 Frequency Analysis

This section focuses on a detailed analysis of the survey responses. Each question from both demographics and Likert-scale sections were analysed individually and presented using visual representations. The table details its frequency, percentage, valid percentage and cumulative percentage. This provides a basic understanding of the characteristics of data to help with further analyses.

4.2.1 Age Groups

Analysis of participants' age groups (Figure 2) showed that most were young adults belonging to age group 25-34 and accounted for 29.8% (106) of the total sample. 35-44 age group comprised 85 participants (23.9%) that represented mid-career students, whereas 18-24 age group that accounted for 20.5% of the participants (73) displayed strong participation from younger learners. While 45-54 age group consisted of 65 students (18.3%), 55 and above age group that comprised 27 participants showed the lowest participation (7.6%). Cumulative percentage values indicated that about half of the participants (50.3%) were younger learners (below 35) in tertiary education.

4.2.2 Gender

The analysis of participants' gender (Figure 3) showed a balanced distribution between the two main categories - female and male. 46.3% of the total participants were female and 42.7% were male. 39 participants (11%) selected the category "Other". This shows the inclusivity of the sample by including the

data that represented genders beyond the traditional male and female genders. This balance was important to understand the different viewpoints about accessibility, enjoyment and usefulness of digital tools in education.

Age Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 - 24	73	20.5	20.5	20.5
	25 - 34	106	29.8	29.8	50.3
	35 - 44	85	23.9	23.9	74.2
	45 - 54	65	18.3	18.3	92.4
	55 and above	27	7.6	7.6	100.0
	Total	356	100.0	100.0	

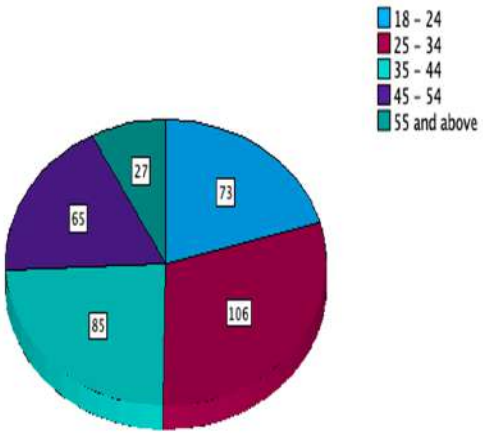

Figure 2: Analysis of Age Groups

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	165	46.3	46.3	46.3
	Male	152	42.7	42.7	89.0
	Other	39	11.0	11.0	100.0
	Total	356	100.0	100.0	

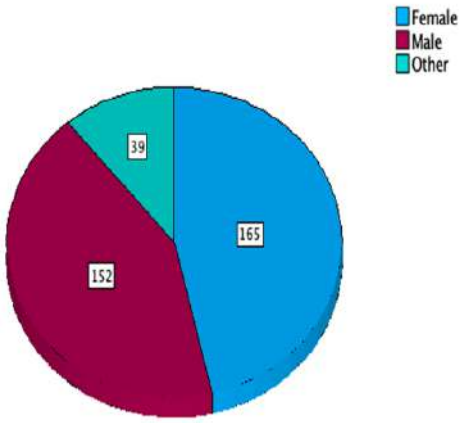

Figure 3: Analysis of Gender

4.3 Cross-Tabulation Analysis

Cross-tabulation analysis was used to explore potential relationships between demographic characteristics and students' perceptions of AI- and Metaverse-integrated learning platforms. This approach examined how the frequency of one variable varied across categories of another, enabling the identification of patterns and associations not evident in simple frequency analyses. To determine statistical significance, Chi-square tests of independence were conducted for each cross-tabulation. These tests compared observed and expected frequencies to assess deviations, with standardised residuals exceeding ±2 indicating meaningful differences. Statistical significance was evaluated using p-values against a 0.05 threshold (Saunders et al., 2023). Four key associations were analysed, providing insights into how demographic factors influenced students' perceptions of emerging learning technologies and they are discussed below:

4.3.1: Association between Age Group and Perceptions of Learning Effectiveness through Virtual Teamwork

Q4: "Working together with others in a virtual space would help me learn better."

Cross-tabulation analysis examined the relationship between age group and perceptions of learning effectiveness through virtual teamwork. Across all age categories, most respondents selected *Neutral* (36.8%), followed by *Agree* (24.2%). Participants aged 25–34 showed a significantly higher-than-expected level of *Strongly Agree* responses (standardised residual = 3.3), indicating a stronger belief in the effectiveness of virtual teamwork compared to other age groups. In contrast, an unexpectedly high number of participants aged 55 and above *Strongly Disagreed* with the statement (standardised residual = 3.3), suggesting lower acceptance of virtual teamwork within this group. Responses from other age categories closely aligned with expected counts, with most ranging between *Neutral* and *Strongly Agree*, particularly among participants aged 18–24.

The Chi-square test confirmed a statistically significant association between age group and perceptions of learning effectiveness through virtual teamwork ($p = 0.001 < 0.05$), indicating that students' views on virtual teamwork effectiveness vary significantly by age.

4.3.2 Association between Gender and Perceptions of Excitement through Game-Like AI Tutoring

Q 9: "Learning with an AI tutor that makes the lesson feel like a game would be exciting."

The cross-tabulation analysis examined the relationship between participants' gender and their perceptions of excitement toward game-like AI tutoring. Overall, most respondents across all gender groups selected either *Neutral* or *Agree*, indicating moderate or uncertain enthusiasm.

Among female participants, neutrality was most common, followed by agreement, with relatively low proportions at the extremes of strong agreement or strong disagreement. This pattern suggests greater uncertainty or mixed feelings toward game-like AI tutoring within this group. Male participants also predominantly reported neutral responses, with smaller proportions indicating agreement or disagreement. A slightly higher-than-expected number of males expressed strong agreement, indicating comparatively higher excitement among a subset of this group. Participants identifying as "Other" showed more polarised responses, with higher proportions selecting both strong agreement and strong disagreement.

Despite these observable differences, the Chi-square test indicated no statistically significant association between gender and excitement toward game-like AI tutoring, as the p-value exceeded the 0.05 significance threshold. This suggests that variations in responses across gender groups were likely due to random variation rather than a meaningful demographic effect. Overall, gender did not reliably predict students' excitement toward game-like AI tutoring features.

4.3.3 Association between Level of Study and Perceptions of Institutional Guidance on Digital Tools

Q 12: " I expect to receive step-by-step guidance from my institution on how to use new digital learning tools."

The cross-tabulation analysis examined the relationship between participants' level of study and their perceptions of institutional guidance on the use of digital tools. Across all study levels, responses were largely concentrated in the *Neutral*, *Agree*, and *Strongly Agree* categories, indicating generally moderate to positive perceptions.

Bachelor's degree students demonstrated relatively higher confidence, with the largest proportion selecting *Strongly Agree* (12.6%), suggesting greater perceived institutional support. Postgraduate diploma students showed the strongest overall agreement, with 35.1% selecting *Agree*, indicating a generally positive perception of guidance received. In contrast, master's degree students and those enrolled in certificates or diplomas exhibited higher levels of disagreement, reflecting greater uncertainty or dissatisfaction with institutional guidance. Certificate or diploma students, in particular, recorded the highest proportion of *Disagree* responses, indicating they were more likely than expected to feel insufficiently supported. PhD students showed no strong agreement and a noticeable level of strong disagreement, suggesting lower expectations or perceived need for institutional guidance at this level.

Despite these observed variations, the Chi-square test indicated that the relationship between level of study and perceptions of institutional guidance was not statistically significant ($p > 0.05$). This suggests that level of study did not reliably predict students' views on institutional guidance regarding digital tools.

4.3.4 Association between Field of Study and Perceptions of Adaptive Learning through Intelligent Tutors

Q15: "Using features like intelligent tutors that suggest adaptive learning paths would make my learning more effective."

Cross-tabulation analysis examined the relationship between students' field of study and perceptions of adaptive learning through intelligent tutors. Overall, responses were concentrated in the *Neutral* (34.6%) and *Agree* (24.7%) categories. Health sciences students demonstrated the most positive perceptions, with 36.2% agreeing that adaptive learning is effective and a positive standardised residual (1.6), indicating higher-than-expected agreement. IT students showed the highest level of strong agreement (14.3%) and a lower-than-expected rate of strong disagreement, suggesting general acceptance of adaptive learning tools. In contrast, business students displayed greater uncertainty, with a high proportion selecting neutral responses. Students from arts and humanities expressed the strongest negative perceptions, recording the highest levels of disagreement across categories.

Despite these observable trends, the Chi-Square test produced a p-value greater than the 0.05 significance threshold, indicating that differences in perceptions across fields of study were not statistically significant. This suggests that students' academic discipline did not reliably predict their views on the effectiveness of adaptive learning technologies.

4.4 Reliability Analysis

Reliability analysis was conducted to assess the internal consistency of survey items prior to forming composite variables for further analysis. Given the mono-quantitative design and the use of multiple Likert-scale items to measure each construct, this step was essential to ensure that each set of items reflected a single underlying concept. Internal consistency was evaluated using Cronbach's alpha, which ranges from 0 to 1 and indicates the degree of reliability, with values of 0.7 or higher considered acceptable for scale construction (Saunders et al., 2023).

The results confirmed that all constructs achieved Cronbach's alpha values above the accepted threshold, demonstrating strong internal consistency. This indicates that the survey items reliably measured their intended constructs and were suitable for aggregation into composite variables for subsequent statistical analysis.

4.5 Descriptive Analysis

Descriptive analysis was conducted to summarise the main features of the dataset by calculating the key descriptive statistics like mean, median, mode, variance and standard deviation and ensure that the dataset is reflecting the sample. These values described the central tendency, variability, skewness and the distribution of responses, helping understand participants' perceptions of the survey questions.

The descriptive statistics for all constructs were calculated using 356 responses and the range of 1 to 5 confirmed that the participants used the full Likert-scale. Mean values of all constructs that were close to 3 indicated that most responses were neutral. PE (3.0552) and PEOU (3.0122) showed marginally higher values, suggesting that students may have perceived online learning platforms with advanced digital tools are somewhat effective and easy to use. MOT showed the lowest mean (2.9260), reflecting that keeping students motivated could be challenging. Median and mode (3.0) values across all constructs were consistent, which showed that most responses were "Neutral" with limited strong agreement or disagreement. Standard deviations that ranged from 0.86039 to 0.98525 showed responses across constructs were distributed in a similar pattern. High variance value (0.98525) of MOT highlighted that the participants experienced different levels of motivation. Skewness values that ranged from 0.061 to 0.221 (≈ 0) indicated that the distribution of data is normal and it is ready for further analysis.

4.6 Correlational Analysis

Correlational analysis was performed to examine the strength of the relationships between the constructs. This was conducted by calculating Pearson's correlation coefficient (r), which ranges from -1 to +1. While a positive r value indicates a direct relationship ($0.35 < r < 0.05$ moderate positive, $0.2 < r < 0.35$ weak positive), a negative value indicates an inverse relationship (Saunders et al., 2023).

Positive and statistically significant (p-value < 0.001) correlation values (Figure 4) confirmed linear relationships among all constructs. While values ranging from 0.242 to 0.495 indicated significant but weak to moderate positive relationships, majority were moderate positive ($0.3 < r < 0.5$) and indicated meaningful connections between constructs. Most relationships involving PEOU were weak positive, including FC ($r = 0.242$), MOT ($r = 0.260$) and ENG ($r = 0.284$). MOT also demonstrated weak positive relationships with FC ($r = 0.242$) and PE ($r = 0.250$).

Correlations

		PEOU	PU	MOT	FC	PE	ENG
PEOU	Pearson Correlation	1	.272**	.260**	.242**	.287**	.284**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001
	N	356	356	356	356	356	356
PU	Pearson Correlation	.272**	1	.354**	.373**	.495**	.479**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001
	N	356	356	356	356	356	356
MOT	Pearson Correlation	.260**	.354**	1	.242**	.250**	.400**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001
	N	356	356	356	356	356	356
FC	Pearson Correlation	.242**	.373**	.242**	1	.422**	.385**
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001
	N	356	356	356	356	356	356
PE	Pearson Correlation	.287**	.495**	.250**	.422**	1	.358**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001
	N	356	356	356	356	356	356
ENG	Pearson Correlation	.284**	.479**	.400**	.385**	.358**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	
	N	356	356	356	356	356	356

**. Correlation is significant at the 0.01 level (2-tailed).

Pearson Correlations

Highly Positive: *(None)*

Positive: *(PEOU <---> PU), (PEOU <---> MOT), (PEOU <---> FC), (PEOU <---> PE), (PEOU <---> ENG), (PU <---> MOT), (PU <---> FC), (PU <---> PE), (PU <---> ENG), (MOT <---> FC), (MOT <---> PE), (MOT <---> ENG), (FC <---> PE), (FC <---> ENG), (PE <---> ENG)*

No Linear Correlation: *(None)*

Negative: *(None)*

Highly Negative: *(None)*

Figure 4: Correlation Analysis of Constructs

4.7 Regression Analysis

A multiple linear regression was performed, to examine the predictive power of independent variables PEOU, PU, MOT, FC and PE on dependent variable ENG. The key outputs were tables displaying the model summary, analysis of variance (ANOVA) and coefficients.

4.7.1 Model Summary Table

The model summary provides an overview of how well the regression model fits the data. The correlation coefficient (R) represents the overall strength of the relationship between the independent variables and the dependent variable, while the coefficient of determination (R^2) indicates the proportion of variance in the dependent variable explained by the independent variables. Higher R^2 values reflect a stronger explanatory power of the model (Saunders et al., 2023).

The R^2 value of 0.338 indicates that 33.8% of the variance in learning engagement (ENG) is explained by the five independent variables: perceived ease of use (PEOU), perceived usefulness (PU), motivation (MOT), facilitating conditions (FC), and performance expectancy (PE). The adjusted R^2 value of 0.329 is very

close to the R^2 value, suggesting that the model is stable and has good potential to generalise beyond the sampled data.

4.7.2 Analysis of Variance (ANOVA)

ANOVA table assessed the overall statistical significance of the entire model. F-statistic (the result of F-test) measures the statistical significance of the entire model in predicting the dependent variable and a corresponding p-value that is less than 0.05 confirms that the model is a reliable predictor (Saunders et al., 2023).
As Figure 5 shows, a relatively large F-statistic (35.773) and the p-value less than 0.001 suggested that the results were not due to chance and the overall regression model proved to be statistically significant.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	96.873	5	19.375	35.773	<.001[b]
	Residual	189.563	350	.542		
	Total	286.436	355			

a. Dependent Variable: ENG

b. Predictors: (Constant), PE, MOT, PEOU, FC, PU

Figure 5: ANOVA Results

4.7.3 Coefficients Table

The coefficients analysis identified which independent variables significantly predicted learning engagement and the strength of their relationships. Unstandardised coefficients (B) indicated the expected change in learning engagement for a one-unit increase in each predictor, while standardised coefficients (β) reflected the relative strength of each predictor. Statistical significance was determined using p-values, with values below 0.05 indicating meaningful effects (Saunders et al., 2023).

The results (Figure 6) showed that perceived usefulness ($\beta = 0.279$), motivation ($\beta = 0.218$), and facilitating conditions ($\beta = 0.179$) were significant positive predictors of learning engagement ($p < 0.001$). Perceived ease of use demonstrated only marginal significance ($p = 0.058$), while performance expectancy was not a significant predictor ($p = 0.223$).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.575	.190		3.031	.003
	PEOU	.086	.045	.089	1.903	.058
	PU	.291	.055	.279	5.257	<.001
	MOT	.199	.043	.218	4.585	<.001
	FC	.167	.046	.179	3.617	<.001
	PE	.061	.050	.065	1.220	.223

a. Dependent Variable: ENG

Figure 6: Regression Coefficients of Independent Variables

4.8 Discussion of Findings

The analyses provided valuable insights for testing the proposed hypotheses and assessing their alignment with the TAM and UTAUT frameworks. The combined conceptual model demonstrated a good fit to the data, explaining 33.8% of the variance in students' learning engagement. This indicates that perceived ease of use, perceived usefulness, motivation, facilitating conditions, and performance expectancy collectively offer a meaningful explanation of engagement with AI- and Metaverse-enhanced learning platforms. The reliability of these predictor variables as a group was further confirmed by the ANOVA results (Figure 5), which reported a highly significant F-statistic (35.773) with a p-value that is less than 0.001.

The correlational analysis (Figure 4) showed positive relationships among all constructs, with significant p-values that are less than 0.001 (2-tailed). Direct relationships of each construct with learning engagement were indicated by positive r values.

PU —— r = 0.479 ——→ ENG
MOT ENG
FC —— r = 0.400 ——→ ENG
PE —— r = 0.385 ——→ ENG
PEOU —— r = 0.284 ——→ ENG

While PU, MOT, FC and PE showed moderate positive correlations with engagement, PEOU demonstrated a weak positive association.

Furthermore, the significant r values between PU and PE (r = 0.495), and FC and PE (0.422) imply the relationships between the predictors of TAM and UTAUT, indicating that students who find the technology useful (PU) and adequately facilitated (FC) are also likely to have a performance expectancy (PE). This shows that these frameworks complement each other when applied to the same technology and confirms the fitness of the combined model. Studies focusing on educational technology adoption reveal that both TAM and UTAUT are widely used (Maghaydah et al., 2024) and validate their successful integration (Granić, 2022).

4.8 Hypotheses Testing

The coefficients table, shown in Figure 6, displayed standardised coefficients (®) and statistical significance (p-value), indicating the contribution of the predictors to the model.

TAM

TAM predictors, PU (H5), PEOU (4) and MOT (H3), were hypothesised to influence learning engagement and results revealed a mixed influence. PU (® = 0.279, $p < 0.001$) was the strongest predictor of the entire model and this highlighted that the support students receive from AI and Metaverse features to complete their tasks determines their engagement with the online learning platforms. This finding supported previous research findings on Metaverse adoption, which shows that PU is an important factor that decides whether students want to engage with the platform (Maghaydah et al., 2024). Research also suggests that both perceived usefulness and perceived ease of use predict students' learning engagement (Hu & Xiao, 2025). However, this study found that PEOU (® = 0.089, p = 0.058) was marginally significant, showing that usefulness of tools matter more than how easy they are to use. This result may have been influenced by level of digital literacy and age group of participants, as evidenced by the analysis of field of study (Figure 6) - which shows that most participants are from Information Technology field and the analysis of age groups - which shows that most participants are young adults. Similar findings were observed in previous studies as well, which suggests that PEOU often influences the outcome through PU, rather than directly (Venkatesh & Bala, 2008). MOT (® = 0.218, $p < 0.001$) was the second strongest predictor of the model, indicating that motivation positively influences learning engagement. Studies reveal that immersive digital features of Metaverse like 3D virtual spaces and gamifying elements increase students' intrinsic motivation through enjoyment

(Muthmainnah et al., 2023). Research related to Self-Determination Theory conclude that intrinsic motivation significantly impacts learning engagement (Hu & Xiao, 2025), which is consistent with the findings of this study.

H5: Supported PU ——— β = 0.279, p < 0.001 ⟶ ENG

H3: Supported MOT ——— β = 0.218, p < 0.001 ⟶ ENG

H4: Not Supported PEOU ——— β = 0.089, p > 0.05 ⟶ ENG

UTAUT

The hypotheses connected to UTAUT constructs PE (H1) and FC (H2) were also examined, and they were partially supported by the results. This study found that FC (® = 0.179, p < 0.001) was a strong predictor of learning engagement, supporting the previous studies that found facilitating conditions are a strong predictor of educational technology adoption (Granić, 2022). This indicates that when students have the necessary resources, guidance and technical support to use technology, they feel confident to engage with it. PE (® = 0.065, p = 0.223) was not a reliable predictor, suggesting that students' future expectations to perform better did not positively influence their current level of engagement. However, studies related to Expectancy-Value Theory highlight that performance expectancy decides the behavioural engagement, which is a key determiner of learning engagement (Nia et al., 2023). Results of this research may have been influenced by the participants' perceptions of immediate, intrinsic and affective factors like motivation and usefulness rather than future performance goals.

H2: Supported FC ——— β = 0.179, p < 0.001 ⟶ ENG

H1: Not Supported PE ——— β = 0.065, p > 0.05 ⟶ ENG

5. CONCLUSIONS

This study employed an integrated Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) framework to examine students' engagement with AI- and Metaverse-enhanced learning platforms. The combined model incorporated perceived usefulness, perceived ease of use, and motivation from TAM alongside performance expectancy and facilitating conditions from UTAUT, enabling a comprehensive assessment of cognitive, emotional, and contextual influences on learning engagement.

A positivist, deductive methodology was adopted using a mono-quantitative, cross-sectional survey design. Data collected through structured Likert-scale items allowed systematic hypothesis testing and alignment with prior technology acceptance research. Statistical analyses confirmed strong internal reliability across all constructs and indicated that students' overall perceptions were largely neutral, reflecting limited exposure to these emerging technologies.

Inferential analysis demonstrated that the integrated model was statistically significant and explained 33.8% of the variance in learning engagement. Perceived usefulness, motivation, and facilitating conditions emerged as significant predictors, while perceived ease of use and performance expectancy did not. These findings suggest that, in the context of advanced and immersive educational technologies, engagement is driven more by perceived value, intrinsic motivation, and institutional support than by usability or anticipated performance gains.

Theoretically, the study extends TAM–UTAUT by validating the importance of intrinsic and experiential factors in emerging educational contexts. The diminished role of perceived ease of use and performance expectancy indicates a shift from traditional acceptance assumptions, particularly among digitally proficient learners. Overall, the findings support the need to adapt established technology acceptance models to better capture the complexities of AI- and Metaverse-enabled learning environments.

5.1 Theoretical Implications

The research findings offered valuable insights into how students decide to accept AI and Metaverse integrated online learning platforms and how this decision affects their learning engagement. Previous studies have widely used TAM to investigate the factors that influence users to adopt intelligent digital tools (Slimi et al., 2025) and both TAM and UTAUT to examine the factors that influence users to adopt immersive technologies (Maghaydah et al., 2024). Some research highlight that sometimes these frameworks need to be extended to support more complex technologies to remain current with the continuous technological advancements as well as to cater the increasing diversity of users in educational sector (Granić, 2022). This study contributes to this notion by empirically validating some of the theoretical relationships presented within these frameworks.

Hypotheses regarding the predictive power of UTAUT construct FC and TAM constructs PU and MOT on learning engagement were validated by the findings of this study as well as previous literature. Most research focusing on technology

acceptance recognises PU as an important determinant of intention to use (Alalwan et al., 2019). PU was initially hypothesised by TAM as a predictor of behavioural intention (Venkatesh & Bala, 2008) and this was confirmed by Fathema et al. (2015) by providing empirical evidence of PU's strong positive effect on intention to use LMSs. Studies also highlight that users' perceptions on benefits and value of technology positively affect their engagement (Hu & Xiao, 2025) through increased satisfaction (Nia et al., 2023). Fabriz et al. (2021) emphasises that the usefulness of technology directly predicts the quality of the interaction with learning material, leading to overall satisfaction with the online learning platforms. Research focusing on novel, immersive technologies like Metaverse highlight that PU emerged as a significant predictor of learners' engagement, especially as a driver of active involvement (Maghaydah et al., 2024) with clear goals (Navarro et al., 2023).

Studies highlight that facilitating conditions (FC) like necessary equipment and technical support (Fathema et al., 2015) that facilitate online learning are essential to motivate the learners and keep them engaged with learning (Hu & Xiao, 2025). Research identifies that not having the required resources or having poor internet connectivity as main barriers to students' involvement in online learning platforms (Akpen et al., 2024; Hu & Xiao, 2025). FC is also regarded as an important factor that predicts users' intention to use and engage with Metaverse (Maghaydah et al., 2024).

Motivation (MOT) derived from immersive digital features is an important construct that predict how people decide to use technology (Marikyan & Papagiannidis, 2025). Studies related to social media confirm that MOT is a strong predictor of intention to use, which suggests that when people enjoy using social media platforms, they are more likely to continue to use it (Alalwan et al., 2019). Some research indicates that MOT that is driven by intrinsic motivation and curiosity is a strong predictor of online learning technology adoption (Zhang et al., 2008) and engagement as it encourages active participation (Hu & Xiao, 2025). Research also find that MOT is a main reason that users adopt immersive technologies (Maghaydah et al., 2024).

However, the results regarding the predictive power of TAM's PEOU and UTAUT's PE on learning engagement were deviated from traditional acceptance models. Research supports PEOU's positive influence on learning engagement and highlights the importance of easy-to-use systems for active participation (Hu & Xiao, 2025), particularly in relation to complex immersive technologies (Maghaydah et al., 2024). However, some empirical studies emphasise that influence of PEOU often reduces over time (Marikyan & Papagiannidis, 2025) or as user develops procedural knowledge (Venkatesh & Bala, 2008). Research

related to online learning systems suggests that higher motivation levels may lower the perceptions regarding the ease of using the technology (Zhang et al., 2008).

PE is regarded as a strong predictor of intention to use (Marikyan & Papagiannidis, 2025), which is a significant driver of learning engagement (Hu & Xiao, 2025). However, literature also suggests that as a model evolves, MOT derived from the digital tools can be perceived as more important than PE, when predicting engagement. This is because intrinsic factors related to enjoyment become the key drivers of continued use rather than initial expectations of performance goals (Marikyan & Papagiannidis, 2025).

Table 2 provides a summary of theoretical implications of the research findings.

Table 2: Comparison of Research Findings with Previous Studies

Research Findings	**Related Previous Research**	**Support Status**	**Rationale**
Motivation derived from immersive features of the Metaverse predicts learning engagement.	Alalwan et al. (2019) Hu & Xiao (2025) Maghaydah et al., (2024) Marikyan & Papagiannidis (2025) (Zhang et al., 2008)	Supported	MOT predicts how people decide to use technology based on enjoyment they experience. It was proven as a strong predictor of intension to use social media and online learning platforms. MOT that is driven by intrinsic motivation and curiosity is a strong predictor of learning engagement, especially with immersive technologies like Metaverse.
Facilitating conditions that support the use of technology for learning predicts learning engagement.	Akpen et al. (2024) Fathema et al. (2015) Hu & Xiao (2025) Maghaydah et al. (2024)	Supported	FCs like necessary equipment and technical support are necessary for technology to function as expected, which keeps users motivated and engaged. Absence of FCs create a barrier to users' involvement with technology. FCs predict users' intention to use and engage with the Metaverse.

Perceived usefulness of AI and Metaverse features predicts learning engagement.	Alalwan et al. (2019) Fabriz et al. (2021) Fathema et al. (2015) Hu & Xiao (2025) Maghaydah et al. (2024) Navarro et al. (2023) Nia et al. (2023)	Supported	PU is a strong predictor of users' decision to use technology and to continue to engage with platforms that use technology if they are satisfied. PU also predicts the quality of the interaction with technology and active participation with clear goals.
Perceived ease of use of technology integrated learning platforms does not predict learning engagement.	Hu & Xiao (2025) Maghaydah et al., (2024) Marikyan & Papagiannidis (2025) (Zhang et al., 2008)	Not Supported	PEOU is strong predictor of learning engagement that facilitates active participation when using immersive technologies like the Metaverse. The reasons that the findings of this research did not support previous research findings could be the natural reduction of PEOU's influence overtime compared to initial stage, users' prior experience with advanced technologies or the dominance of motivation through enjoyment.
Performance expectancy from the technology integrated learning platforms does not predict learning engagement.	Hu & Xiao (2025) Marikyan & Papagiannidis (2025)	Not Supported	PE is a strong predictor of users' intention to use technology, which is a key driver of engagement. The reason that the findings of this research did not support previous research findings could be the dominance of intrinsic motivation that leads to enjoyment, over initial performance expectations.

(Source: Author)

5.2 Future Works

Findings and the acknowledged limitations suggest several avenues for future research to gain greater insights into integration of AI and Metaverse in NZ's online tertiary education sector.

5.2.1 Experiential and longitudinal Studies

As universities begin to implement AI and Metaverse integrated online learning platforms, future studies should focus on gathering data based on students' actual involvement and performance goals. A longitudinal design allows researcher to capture changes over time and explain the cause-and-effect relationships among constructs. This can also help validate the findings of this research regarding the weak influence of PEOU and PE by checking whether these aspects reduces as students get familiar with technology.

5.2.2 Mixed-Method Approach

Future research could incorporate both quantitative and qualitative methods to gain a deeper understanding of how students cognitively and emotionally experience the AI and Metaverse integrated learning. Conducting interviews or focus groups with students who report extremely high or low levels of engagement can help explain their perceptions collected through quantitative methods.

5.2.3 Broadening Generalisability

Future studies could conduct similar research in other countries that have different educational systems, economies or cultural backgrounds to find out how they influence the main variables of the research. They can test the same model in different educational sectors like primary or secondary schools and investigate whether the constructs PU, FC and MOT still predict learning engagement. Researchers should also explore how these advanced technologies might affect different student groups like students with limited resources or disabilities, to make sure that new technologies are used to offer inclusive and ethical education for everyone.

5.2.4 Inclusion of Additional Constructs

Future research must include additional constructs in the conceptual model to find out the impact of external factors on how users decide to adopt technology and continue to use it. For example, variables like technology anxiety, digital literacy and trust could be used to predict learning engagement when introducing new technology. Constructs like habit and social influence could be added to explain

long-term engagement with the technology as this could be affected by societal factors like peer-pressure.

5.2.5 Increasing the Sample Size

Future studies should increase the sample size as it makes the research findings more reliable as well as accurate for generalising. Although this research helped to gain deeper understanding of how students viewed the use of AI and Metaverse technologies in online learning systems, collecting data from a higher number of participants can better reflect the diverse opinions of NZ's tertiary students. A larger group that includes students from different universities, cultures, educational backgrounds and experiences with digital tools can make the research finding more generalisable.

5.3 Recommendations for Effective Integration of AI and Metaverse Technologies

To enhance learning engagement, tertiary institutions should prioritise demonstrating the perceived usefulness of AI and Metaverse features by clearly linking tools such as intelligent tutoring, personalised feedback, and virtual collaboration spaces to academic outcomes. Motivation should be strengthened through immersive and gamified learning designs that promote curiosity, autonomy, and enjoyment, supported by staff training in engaging digital pedagogy. Strong facilitating conditions, including reliable infrastructure, technical support, staff capability building, equitable access to devices, and clear data governance, are essential for sustained adoption. Although ease of use was not a strong predictor of engagement, intuitive design and onboarding support remain important to ensure smooth initial adoption and reduce early technical barriers.

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Impact of Foreign Direct Investment, Economic Growth, and Trade Openness on Carbon Emission in New Zealand

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ABSTRACT

'Toitū te marae a Tāne, toitū te marae a Tangaroa, toitū te iwi.' If the land is well and the sea is well, the people will thrive. This research examines the impact of economic growth (GDP), foreign direct investment (FDI) and trade openness (TO) in New Zealand. It also considers the control variables, land conversion to agricultural purpose (Land), urban population growth rate (Popu) and electricity consumption to produce per unit of GDP (EC_GDP) on Carbon Di-Oxide (CO2). This paper used the Ordinary Least Squares (OLS), Auto Regressive Distributed Lag (ARDL), ARDL bound test, and Todo Yamamoto (TY) Granger causality tests to find the Environmental Kuznets curve (EKC), Pollution Haven Hypothesis (PHH) and pollution Halo-Hypothesis (P-HH) in New Zealand. Later, the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) were applied to confirm the findings and the long-run stability of the outcomes. The findings of this research confirm that, for the sample period, New Zealand exhibits an inverted U-shaped relationship between GDP and CO2 emissions, validating the EKC hypothesis. However, FDI fails to validate either PHH or P-HH hypotheses, highlighting that there is still room to embrace more FDI without increasing CO2 emissions.

Keywords: *FDI–environment nexus, Environmental Kuznets curve (EKC), Pollution Haven Hypothesis (PHH), ARDL bounds testing, Long-run cointegration*

1. INTRODUCTION

Greenhouse gas (GHG) emissions are rising globally, contributing to a warmer planet and various environmental challenges. According to the Intergovernmental Panel on Climate Change (IPCC), if significant action is not taken to curb these emissions, global temperatures could increase by around 4°C by 2050. These

emissions lead to extreme weather events, climate change and a significant rise in sea levels. CO2 holds the largest share of global GHG emissions, with methane, nitrous oxide, and other gases contributing significantly. Among all GHGs, carbon dioxide (CO2) is the leading reason for global warming, and experts urge the adoption of carbon-reducing policies to limit CO2 emissions. Thomas et al. (2023) exposed the vulnerability of New Zealand through the simulation with and without greenhouse gases, and they found that the atmosphere's heat is two to three times higher when considering CO2. The IPCC warns that limiting global temperature rise to 1.5°C or 2°C without rapid reductions in emissions will be impossible. Human activities for business, mainly burning fossil fuels for energy, transportation, and industry, solely related to trade and economy, disrupt the natural balance of CO2 in the atmosphere, exacerbating environmental damage such as ecosystem loss, rising sea levels, and global warming. The Environment Aotearoa 2019 report published by the Ministry for the Environment highlighted the impact of human activity on New Zealand's Environment. The report mentioned that prime sources of air pollution include domestic coal, wood heating, and vehicle emissions. For instance, one of the highest car ownerships among OECD countries, New Zealand, faces adverse effects from vehicle-related pollution. As a result, greenhouse gas levels have surged by 42% from 1990 to 2013. The report also raises concerns about the extinction of 86 species and plant life loss over the past 15 years (Ministry for the Environment, 2019).

Climate change also increases the likelihood of spreading diseases and outbreak pandemics by affecting the natural ecosystem and threatening humans and wildlife. For instance, in Aotearoa, the Ross River Virus may spread due to climate-adaptive factors (Johnson et al., 2021). Moreover, ethnic minorities within Aotearoa, such as Māori communities, are more exposed to vulnerability related to climate-induced diseases as they live more close to nature (Johnson et al., 2021). Additionally, climate change raises the risk of social inequality and economic vulnerability. In the case of social and economic vulnerability, marginal populations, which are ethnic minorities, Māori, for example, are more prone to face the worst.

New Zealand's geographical isolation and formation makes her more expose to natural disasters or environmental changes. As such, New Zealand has set greenhouse gas (GHG) emissions targets under the Zero Carbon Act of 2019. The country aims to reduce net emissions of all GHGs, except biogenic methane, to zero by 2050 and a minimum reduction target of 10 percent by 2030. Although each nation has its own target to halt depleting the environment, a similar target for the global context is reducing New Zealand's net GHG emissions to 50% below gross 2005 levels by 2030 (Ministry for the Environment, 2023).

International communities have a consensus that environmental quality must be considered as the basis for the economic prosperity of any economy (Gawel & Cooper, 2022). This argument supports the global necessity to pursue sustainable development. Therefore, green growth will foster economic progress while ensuring natural support to our collective society and maintaining the ecosystem for future generations (Organisation for Economic Co-operation and Development, 2023). For that reason, researchers use CO2 as a proxy variable to understand environmental degradation by economic activities (Destek & Sarkodie, 2019; Rahman et al., 2020; Raza & Shah, 2018).

Over the past five decades, global economic integration has intensified through liberalised trade and capital flows, with foreign direct investment (FDI) playing a pivotal role in driving growth (Harvey, 2005). So, FDI is a catalyst for global trade, and the concept of globalisation depends mainly on this international investment. Global FDI stood for $1.3 trillion in 2022, twelve percent lower than before due to low financial flows and transactions in developed countries. This global trend of curbing FDI is a result of the war in Europe and the COVID-19 pandemic. On the contrary, New Zealand shows a significant increase in FDI in 2022. In 2022, it stood at $8.34 Billion, an 88.8% year-on-year growth, and the FDI stock amounted to 38.8% of the country's GDP.

For small, open economies such as New Zealand, FDI is particularly vital as a supplement to domestic investment. Beyond capital inflows, FDI facilitates knowledge spillovers, technological diffusion, and productivity gains, which are essential for competitive and sustainable growth (Habib-ur-Rahman et al., 2020; Haug & Ucal, 2019). Consequently, FDI is often employed as a proxy for financial development, given the strong linkage between robust financial systems and international investment attraction (Hobbs et al., 2021; Shahbaz et al., 2015).

Trade openness (TO) further complements FDI by reducing tariff and non-tariff barriers, facilitating business activity and capital mobility (Harvey, 2005). While TO stimulates economic growth, it also influences environmental outcomes by intensifying production and trade-related emissions (Habib-ur-Rahman et al., 2020), yet at a potential environmental cost. With New Zealand's GDP reaching NZD 405 billion in 2024, identifying a sustainable balance between economic expansion and environmental protection remains a critical policy and research challenge(Faris Alshubiri & Mohamed Elheddad, 2020; Grossman & Krueger, 1995; Habib-ur-Rahman et al., 2020).

This research investigates the impact of foreign direct investment (FDI), gross domestic product (GDP), and trade openness (TO) on carbon dioxide (CO_2) emissions in New Zealand to assess how economic and business activities

influence environmental outcomes. To enhance robustness, land converted to agriculture (Log_Land), urban population growth (Log_Popu), and electricity consumption per unit of GDP (Log_EC_GDP) are incorporated as control variables. Specifically, this paper investigates whether FDI inflows, gross domestic product (GDP), and trade openness significantly affect CO_2 emissions in the long and short run. To account for structural and demographic factors that may influence environmental outcomes, we include land converted to agriculture, urban population growth, and electricity consumption intensity as control variables.

The relationship between GDP and CO_2 emissions is analysed within the Environmental Kuznets Curve (EKC) framework, while the interaction between FDI and environmental quality is examined using the Pollution Haven Hypothesis (PHH) and Pollution Halo Hypothesis (P-HH). The study is guided by three core questions: (i) how foreign direct investment influences CO_2 emissions in New Zealand; (ii) how gross domestic product (GDP) affects emission dynamics; and (iii) how trade openness impacts environmental outcomes. By empirically examining these relationships, the analysis evaluates whether the observed patterns are consistent with the assumptions of the EKC, PHH, or P-HH in the New Zealand context.

This research covered data from 1970 to 2023 are utilised, allowing for the examination of long-term structural changes in the New Zealand economy. Accordingly, a comprehensive econometric framework is employed. The research utilises the Autoregressive Distributed Lag (ARDL) approach and ARDL bounds testing to examine both short-run and long-run dynamics. To further investigate causal relationships, the Toda–Yamamoto (TY) Granger causality procedure is implemented. In addition, Ordinary Least Squares (OLS) estimation is conducted as a baseline specification, while Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) are applied to assess long-run robustness and model stability. The ARDL framework is particularly appropriate in this context, as it effectively estimates long-run relationships and short-run adjustments while performing reliably with relatively small sample sizes (Villanthenkodath & Arakkal, 2020).

Despite extensive international literature on the nexus between FDI, economic growth, and CO_2 emissions, empirical evidence specific to New Zealand remains limited. Only one identified study has examined the EKC in this context (Villanthenkodath & Arakkal, 2020). and the absence of updated analyses constrains informed policymaking. Addressing this gap, the present study re-examines these relationships through a neoliberalism lens and applies advanced

analytical techniques to forecast future CO_2 emissions based on historical GDP and FDI trends.

The findings are expected to assist New Zealand businesses in complying with global environmental standards and adopting sustainable production practices. Evidence from the World Bank's Doing Business indicators highlights the role of developed economies in influencing emissions outcomes in developing countries (Shahbaz et al., 2019). Similarly, research on Gulf Cooperation Council countries shows a short-run positive but long-run negative relationship between FDI and CO_2 emissions, leading to policy shifts toward afforestation and sustainable production (Al-mulali & Tang, 2013). This research helped Gulf nations to revise their development policy. As a result, Gulf nations adopt more forestation policy and sustainable production practices. Overall, this study provides policy-relevant insights for shaping trade and energy strategies that support environmentally sustainable economic development in New Zealand, consistent with (Shahbaz et al., 2019).

2. LITERATURE REVIEW

To examine the research question RQ-1, this thesis used widely accepted theories: the Pollution Haven Hypothesis (PHH) and the Pollution Halo Hypothesis (P-HH). Firstly, Pethig (1976) developed the pollution haven hypothesis, and another is the pollution halo hypothesis, which was developed by Porter & van der Linde (1995). The PHH argues that when FDI increases, pollution also increases, or in a more practical way, where regulation of protecting the environment is low, FDI goes in that direction (Bakirtas & Cetin, 2017; Shahbaz et al., 2015). Shahbaz et al. (2015) argued that FDI degrades the environmental quality in developing nations due to limited regulations concerning environmental issues, and the same view has been provided to establish the transfer of investment from developed economies to developing. The research used panel data unit root tests and FMOLS to confirm the existence of PHH. Mert et al. (2019) provided a similar message after examining the impact of GDP, energy use, and FDI on CO2 emissions in 26 EU countries, and their findings confirm the EKC hypothesis and PHH, which vary across EU groups. It also prescribed enhancing green technology and restricting environmental regulations on FDI. They also tested their hypothesis to find the practical usability of the theories to establish environmentally sustainable businesses.

In contrast to PHH, the P-HH is also popular among academicians. The P-HH hypothesis suggests that Foreign Direct Investment (FDI) could positively influence environmental quality. This hypothesis is based on the premise that FDI can facilitate the transfer of cutting-edge technologies and knowledge to the host economy. In the endogenous growth model, economic development is dependent

on technological innovation and knowledge development, which, on the other hand, depends on FDI to be transferred to developing nations from developed ones. Jiang et al. (2018) found that FDI negatively impacted air quality in China, which also affirmed the existence of P-HH.

Although there are positive and negative arguments against the FDI's impact on host economies, countries with least developed and developing economies tend to engage in a competition to allure more FDI. In particular, the competition is higher among those economies who are willing to sacrifice their environment due to attract FDI, which causes a significant deregulation of environmental protection. Tayyar (2022) expresses the view that as environment does not have any political border, it affects the whole planet either direct or indirect environmental pollution. However, as FDI is a foreign investment in the host economy, it may depends on geo-political issues and economic policies (Harvey, 2005). Some studies highlight the importance of a country's position in the economic power in the context of FDI for economic growth. Clark and Kentor (2022) considered that the economies, which are closer to the centrality of global power may be able to gain more business benefits due to greater exposure to markets, innovations, and bargaining power. The motivation behind FDI is to establish a strategic and settled relationship between the economies. The components of FDI include the direct investor's acquisition of shares, reinvestment earnings, and intracompany transactions (Organisation for Economic Co-operation and Development, 2023).

This impact can be explained in two ways. Pollution Haven Effect, where FDI may increase the level of pollution, and Pollution Halo Effect, where FDI may positively impact environment by modern technological advancement. Considering the conflicting theories demonstrated by the Pollution Haven Hypothesis (PHH) and the Pollution Halo Hypothesis (P-HH), this study aims to investigate the overall impact of foreign direct investment (FDI) on environmental standards in New Zealand. By examining both potential outcomes, this research seeks to provide a comprehensive understanding of how FDI influences environmental practices in the host country. Hence, the following null hypothesis has been formulated:
H_1 Foreign direct investment (FDI) has no impact on CO_2 in host countries.

For economic growth, the impact of GDP on CO_2 is widely examined through the lens of EKC because some find a positive and some find a negative relationship, and even the positive and negative relationships are not linear (Grossman & Krueger, 1995; Hobbs et al., 2021; Rahman et al., 2020; Raza & Shah, 2018; Villanthenkodath & Arakkal, 2020). EKC has been found between the nexus of economic growth and environmental degradation (Grossman & Krueger, 1995).

Furthermore, the GDP square value, which is the square of GDP, used in the research to test the EKC hypothesis (Destek & Sarkodie, 2019; Jebli, M.B. et al., 2016; Rahman et al., 2020; Raza & Shah, 2018; Villanthenkodath & Arakkal, 2020).

In his seminal work, Kuznets (1955) described inequality raises during the early age of economic development but starting to decrease after a certain level of development occurred. This idea was further developed and implemented to find environmental degradation, where initially, environmental pollution increases as an economy develops, and it starts falling after reaching the threshold. This theory is represented by an inverted U-shaped curve, later popularised as the Environmental Kuznets Curve or EKC (Grossman & Krueger, 1995).

To examine the impact on environment this research considers CO_2 as dependent variable, which also acts as a proxy variable for environmental degradation. Using CO_2 as a dependent variable is found in the vast literature (Destek & Sarkodie, 2019; Jebli, M.B. et al., 2016; Rahman et al., 2020). In addition, many researchers confirm the negative relationship between FDI, EG and the environment, denoted here by CO_2. Faris and Mohamed (2020) applied more sophisticated analytical methods such as panel OLS estimator via fixed-effects and generalised method of moments (GMM) with fixed effects-instrumental variables (FE-IV) to examine the relationship between foreign finance, economic growth and environment in 32 countries. This research found the short-run negative effect on the environment, and in the long-run, after reaching a threshold, the impact becomes positive. Additionally, the research considered the policy-level usefulness of the research. Hence, to examine the impact of GDP on CO2 in New Zealand this research tests the EKC hypothesis, and to investigate it the following null hypothesis has been formed:
H_2 There is no inverted U-shaped relationship between GDP and CO_2 emissions.

Numerous academic researchers used trade openness[1] in their study to test the EKC hypothesis, which was also used as a proxy- variable of globalisation (Destek & Sarkodie, 2019; Habib-ur-Rahman et al., 2020; Jebli, M.B. et al., 2016; Rahman et al., 2020; Raza & Shah, 2018; Villanthenkodath & Arakkal, 2020). Globalisation helps investors invest in other economies to maximise profitability, and capital movement is necessary to invest outside the border, which initiated the formulation of new regulations to embrace foreign investment. Hence, globally, trade openness becomes the indicator of free trade agreements and the removal of tariff or non-tariff barriers among nations; this is another phenomenon of neoliberalism (Harvey, 2005). Further, in business world, especially at the

[1]Trade openness is calculated by the sum of merchandise exports and imports divided by the GDP, all value in current U.S. dollars.

policy level, the direction of foreign investment and sustainable production practices is a pressing issue nowadays. Cakmakçı et al., (2023) suggested bringing the necessary changes in production practice policy for food production to protect the ecosystem for the future. Similar policy research conducted on China where researchers shown that intermediate import liberalization on green technologies bolstered the Chinese economy. Moreover this trade policy promoted the green innovation as well (Cakmakçı et al., (2023). Hence, this research considers the impact of TO on environment as a policy tools, and to examine the relationship between TO and CO2 the following null hypothesis has been formed:

H_3 TO does not have any significant influence on CO_2 emissions.

This research makes some novel contributions to the literature by focusing solely on New Zealand (NZ). Few studies have explored the interrelationships between GDP, FDI, TO and CO2 emissions in NZ. Moreover, only a few studies have been found which have covered the FMOLS and DOLS in their studies to confirm the findings. Another key idea is including electricity consumption per unit of GDP produced in New Zealand in the study. This control variable can capture Aotearoa's energy sovereignty issue as New Zealand focuses more on electricity generation to meet energy demand.

3. METHODOLOGY

This research uses OLS as baseline regression, ADF and KPSS for unit root test, ARDL and ARDL bound test for short-run and long-run relationship, TY Granger causality test for causality analysis, and FMOLS and DOLS models for testing long-run stability to define the models and analysis steps of EKC, PHH and P-HH hypotheses.

3.1 Data and Variables

Ren et al. (2014) explained that understanding a single country's complexity time series data provides a better basis. Hence, this thesis considers the time series data from 1970 to 2022. The research uses secondary data from the World Bank's official website, World Development Indicator[2] and Our World in Data. Therefore, the sampling method of data collection is not a critical issue for this research. However, all data cross-checks with the New Zealand government's official websites for better clarification. The time frame was chosen on the premise of neoliberal ideology (Harvey, 2005).

[2] https://wdi.worldbank.org/table

Based on the literature review, the following variables were considered to carry out the research: CO_2 is the dependent variable, which also acts as a proxy variable for environmental degradation. FDI, GDP and TO are independent variables. The amount of CO_2 in this research is measured in metric tons, GDP and FDI in billion USD. On the other hand, TO was calculated by the sum of merchandise exports and imports divided by the value of GDP, in current U.S. dollars and measured as billion USD. Moreover, this research considers land converted to agricultural (Log_Land), urban population growth (Log_Popu) and electricity use per unit of GDP production (Log_EC_GDP) as control variables. Table 1 displays the details of each variable.

Table 1: Variables description, measurement and data sources (Source: Author)

Variable	Description	Measurement	Source
CO2	Carbon dioxide emission	Million metric tons (Mmt)	Our World in Data
GDP	Gross domestic product	Constant 2015 US$	WDI, World Bank
TO	Trade Openness (TO)=Merchandise Exports+Merchandise Imports/GDP		WDI, World Bank
FDI	Foreign direct investment	Millions of USD	WDI, World Bank
Land	Land converted to Agricultural	Percentage of total	WDI, World Bank
Population	Urban population growth rate	Percentage	WDI, World Bank
EC_GDP	Electricity consumed for per unit of GDP production	Killowatt per hour	Our World in Data

3.2 Research design and Analysis Methods

To begin with, by converting all variables CO2, GDP, FDI, TO, Land, Popu and EC_GDP into natural logarithms, Equation 1, helps to normalise the variables. Log-transforming all variables can also provide a consistent framework for interpretation (Tayyar, 2022). Then this research performs the OLS models as baseline regression (Equation 2). After that this research checks data stationarity to run the ARDL model, as ARDL model can only handle 1(0) and 1(1). To check the stationarity, perform two tests, the Augmented Dickey-Fuller (ADF) test (Equation 3) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Equation 4). The ADF test examines whether the series has a unit root (non-stationary), while the KPSS test checks for stationarity (Dickey & Fuller, 1979). If the ADF test result is less than the prescribed critical value, it rejects the null hypothesis, which indicates that the series is stationary (Dickey & Fuller, 1979). Alternatively, if the KPSS test statistic exceeds the prescribed critical value, this research will reject the null hypothesis (< 0), suggesting that the series is non-stationary (Kwiatkowski et al., 1990).

$$(ln\ ln\ (CO2_t)\ ,ln\ ln\ (GDP_t)\ ,ln\ ln\ (FDI_t)\ ,ln\ ln\ (TO_t)\ ,ln\ ln\ (Land_t)\ ,\ ln\ ln\ (Popu_t)\ ,ln(EC\_GDP_t)\ ) \quad (1)$$

$$(ln\ ln\ (CO2)\ t = \beta 0 + \beta 1\ ln\ ln\ (GDPt)\ + \beta 2\ ln\ ln\ (FDIt)\ + \beta 3\ ln\ ln\ (Tot)\ + \beta 4\ ln\ ln\ (Landt)\ + \beta 5\ ln\ ln\ (Poput)\ + \beta 6\ ln\ ln\ (EC\_GDPt)\ +\ \epsilon t \quad (2)$$

$$\Delta\, ln\, ln\left(CO2_t\, GDP_t\, FDI_t\, TO_t\, Land_t\;\; EC\_GDP_t\, Popu_t\;\;\right) = \alpha + \beta t + \gamma$$
$$ln\, ln\left(CO2_{t-1}\, GDP_{t-1}\, FDI_{t-1}\;\; EC\_GDP_{t-1}\, Popu_{t-1}\, Land_{t-1}\;\; TO_{t-1}\;\;\right) + \sum_{i=1}^{p}\;\;\; \delta_i \Delta$$
$$ln\, ln\left(CO2_{t-1}\, GDP_{t-1}\, FDI_{t-1}\;\;\;\; EC\_GDP_{t-1}\, Popu_{t-1}\, Land_{t-1}\;\; TO_{t-1}\;\;\right) + \;\epsilon_t \qquad (3)$$

Null Hypothesis H_0.

The series has a unit root (non-stationary).

$$ln\, ln\left(CO2_t\, GDP_t\, FDI_t\, TO_t\, Land_t\;\; EC\_GDP_t\, Popu_t\;\;\right) = \mu + \beta t + u_t \qquad (4)$$

Null Hypothesis H_0. The series is stationary.

Finding structural breaks is essential for understanding shifts in the trend and relationship among CO2 emissions, GDP, FDI, and TO. Equation 5, the Lagrange Multiplier (LM) test, is a robust statistical tool to identify the existence of structural breaks in the data, which may significantly influence the relationships among variables and the model's validity (Breusch & Pagan, 1979).

$$LM = \frac{T \cdot R^2}{1-R^2} \qquad (5)$$

The F-test (Bound Test) checks the long-run relationship within the ARDL framework. Equation 6 checks for long-term relationships or cointegration among the variables. If the F-statistic value is greater than the upper bound critical value, it rejects the null hypothesis. Hence, the result indicates a common trend among the variables (Pesaran et al., 2001). The Opposite happens if the F-statistic value is less than the lower bound critical value.

$$F = \frac{\frac{RSS_{restricted} - RSS_{unrestricted}}{3}}{\frac{RSS_{unrestricted}}{n-k}} \qquad (6)$$

Next, the ARDL model in Equation 7 examines the relationship between CO2 emissions, GDP, FDI, TO, Land, Popu and EC_GDP. The strength of this model is that it considers both short-run and long-run relationships, as well as the lagged effects of the variables. The dependent variable in ARDL model is the natural logarithm of CO2 emissions $ln\, ln\left(CO_2(t)\right)$. In contrast, the independent variables are the natural logarithms of GDP $ln\, ln\left(GDP(t)\right)$,GDP squared $\left(ln\, ln\left(GDP(t)\right)\right)^2$, FDI $ln\, ln\left(FDI(t)\right)$,TO $ln\, ln\left(TO(t)\right)$. The error term $\epsilon(t)$ in

this model captures the unexplained variation of CO2 emissions which GDP, FDI and TO fails to explore (Pesaran et al., 2001).

The ARDL Model

$$ln(CO2_t) = \alpha + \sum_{i=1}^{p} \phi_i ln(CO2_{t-i}) + \sum_{j=0}^{q} \gamma_j ln(GDP_{t-j}) + \sum_{j=0}^{q} \gamma_j^2 (ln(GDP_{t-j}))^2 + \sum_{k=0}^{r} \delta_k \, ln\, ln\, (FDI_{t-k}) + \sum_{m=0}^{r} \lambda m ln(Land_{\,t-m}) + \sum_{l=0}^{s} \eta_l \, ln\, ln\, (TO_{t-l}) + \sum_{n=0}^{s} \mu n ln(EC_{GDPt} - n) + \sum_{o=0}^{r} \theta o ln(Popu_t - o) + \epsilon_t \quad (7)$$

After that, the TY Granger causality test checks (Equation 9) whether one time series can predict another. Specifically, it tests whether GDP, FDI, and TO can predict CO2 emissions (Equation 12). The null hypothesis (H_0: No Granger causality) is tested against the alternative hypothesis (H1: Granger causality exists). If the F-statistic is greater than the critical value, it rejects the null hypothesis, indicating that CO_2 emissions Granger-cause the independent variables (Granger, 1981).

TY Granger Causality Test

$$ln\, ln\, (y_t) = \alpha + \sum_{i=1}^{p} \beta_i \, ln\, ln\, (y_{t-i}) + \sum_{j=1}^{q} \gamma_j \, ln\, ln\, (x_{t-j}) + \epsilon_t \quad (8)$$

$$ln\, ln\, (CO2_t) = \alpha + \sum_{i=1}^{p+d} \phi_i \, ln\, ln\, (CO2_{t-i}) + \sum_{j=1}^{p} \gamma_j \, ln\, ln\, (GDP_{t-j}) + \sum_{k=1}^{p} \delta_k \, ln\, ln\, (FDI_{t-k}) + \sum_{l=1}^{p} \eta_l \, ln\, ln\, (TO_{t-l}) + \sum_{l=1}^{p} \mu_l \, ln\, ln\, (Popu_{t-l}) + \sum_{l=1}^{p} \lambda \, ln\, ln\, (Land_{t-l}) + \sum_{l=1}^{p} \theta \, ln\, ln\, (EC\_GDP_{t-l}) + \epsilon_t \quad (9)$$

Specific statistical tests check the ARDL model's robustness (see equations 10,11 and 12). The Durbin-Watson test, Equation 10 examines the autocorrelation in the residuals of the regression model. If the Durbin-Watson test value is close to 2, it indicates no autocorrelation (Durbin & Watson, 1950). Alternatively, the

Breusch-Pagan-Godfrey test (Equation 11) analyses heteroscedasticity in the residuals. If the test result is greater than the critical value, it rejects the null hypothesis, indicating the presence of heteroscedasticity (Breusch & Pagan, 1979). Furthermore, the Jarque-Bera test (Equation 12) applies to check for the normality of the residuals. If the result exceeds the critical value, it rejects the null hypothesis, indicating that the residuals are not normally distributed (Jarque & Bera, 1980).

$$DW = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \tag{10}$$

$$\chi^2 = n \cdot R^2 \tag{11}$$

$$JB = \frac{n}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \tag{12}$$

To check the response in one of the independent variables shock on CO2 emissions, this research also uses Impulse Response Functions (IRF). The Cumulative Sum of Recursive Residuals (CUSUM) will show the stability of the ARDL model parameters over time. Further, the Error Correction Term (ECT) plot can show the adjustment speed of CO2 emissions back to equilibrium after deviation (Habib-ur-Rahman et al., 2020; Mert et al., 2019; Villanthenkodath & Arakkal, 2020; Wen et al., 2023). Finally, FMOLS and DOLS tests check the long run stability of the results.

3.3 Ethical consideration

This research uses publicly available data. Hence, the ethical issue of this research aligns with the data usage policy of the World Bank and Our World in Data. Moreover, no prior consent is required for data usage. Furthermore, this research considers the potential bias issues of publicly available data, as mentioned by (Cowton, 1998).

4. EMPIRICAL RESULTS

4.1 Descriptive statistics

LOG_CO2 records a mean of 17.10 with low variability (SD = 0.30), indicating broadly stable emissions over time; however, negative skewness (−0.57) and the JB test (p = 0.056) suggest deviations from normality. LOG_GDP (mean =

11.61; SD = 0.38) shows moderate dispersion and near-normality (JB = 0.14), consistent with New Zealand's steady economic expansion. LOG_FDI exhibits high volatility (mean = 8.72; SD = 0.30), strong negative skewness (−1.13), excess kurtosis (8.43), and non-normality (JB = 0.000), reflecting episodic negative inflows. LOG_TO demonstrates limited variability and a normal distribution (JB = 0.14). Among control variables, LOG_EC_GDP and LOG_LAND remain stable and normally distributed, while LOG_POPU shows non-normality (JB = 0.000) despite an overall upward trend.

4.2 Correlation analysis

The correlation analysis reveals the relationships between Log_CO2 and other variables. LOG_GDP and Log_CO2 have a strong positive correlation, significant at the 1% level ($p<0.01$).

4.3 Baseline Regression for each variable

To examine the determinants of CO_2 emissions in New Zealand, OLS regressions are estimated both separately and jointly for foreign direct investment (FDI), economic growth (GDP), trade openness (TO), land use, population, and energy consumption intensity (EC_GDP). Estimating single-variable models allows the marginal effect of each determinant to be isolated, while the combined specification captures their joint influence and reduces potential bias arising from interaction effects and multicollinearity highlighted in previous studies (Bouznit & Pablo-Romero, 2016; Chen et al., 2024; Gillani & Abbas, 2023).

Table 2 reports that the regression coefficient for Log_GDP is 0.7162, with a standard error of 0.0474, yielding a t-value of 15.1185 and a p-value of 0.0000. This result is statistically significant at the 1% level and indicates that economic growth increases CO_2 emissions in New Zealand. Consequently, the null hypothesis is rejected, and the second hypothesis of this study is not supported, thereby addressing RQ2 and confirming the existence of the Environmental Kuznets Curve (EKC). Notably, GDP alone explains approximately 81.4% of the variation in CO_2 emissions, highlighting its dominant role. These findings are consistent with prior empirical evidence (Ali et al., 2021; Al-Mulali et al., 2016; Dogan & Turkekul, 2016; Rahman et al., 2020; Wang, Wang, et al., 2024).

Log_TO also exhibits a positive and statistically significant relationship with CO_2 emissions. However, the adjusted R-squared indicates that trade openness

explains only 18.9% of the variation in emissions, suggesting limited explanatory power when considered independently. This result leads to the rejection of Hypothesis 3 and addresses RQ3, while aligning with studies that report a weak or context-dependent trade–emissions relationship (Alotaibi et al., 2020; Frankel & Rose, 2005; Gillani & Abbas, 2023; Haug & Ucal, 2019; Hobbs et al., 2021; Raza & Shah, 2018).

In the multivariate OLS model (Table 2, Model 7), GDP and trade openness remain positive and statistically significant at the 1% level, confirming their combined influence on emissions. In contrast, foreign direct investment exhibits a negative but statistically insignificant coefficient (–0.024), indicating no meaningful effect on CO_2 emissions and providing no empirical support for either the Pollution Haven or Pollution Halo hypotheses. Robustness checks confirm the stability of these estimates.

Table 2: *Baseline OLS model results*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	8.7865***	-5.7178	14.1054***	-8.1174***	3.7357	14.9461***	-7.5131***
Std. Error	0.55	6.303	1.138	2.045	3.234	2.322	2.084
p-value	< 0.0001	0.369	< 0.0001	< 0.0001	0.254	< 0.0001	0.001
log_GDP	0.7162***			0.9656***			1.0035***
Std. Error	0.047			0.075			0.091
p-value	< 0.0001			< 0.0001			< 0.0001
log_TO		9.6332***			6.0054***		-0.3112
Std. Error		2.66			1.448		0.973
p-value		0.001			< 0.0001		0.751
log_FDI			0.3439**			-0.0155	-0.0756*
Std. Error			0.13			0.072	0.034
p-value			0.011			0.83	0.033
log_Population				-0.1009	-0.3394	-0.7954**	-0.1216
Std. Error				0.145	0.268	0.286	0.146
p-value				0.49	0.211	0.008	0.408
log_Land				-0.5677	-3.0170***	-3.7216***	-0.5779*
Std. Error				0.289	0.327	0.341	0.286
p-value				0.055	< 0.0001	< 0.0001	0.049
log_EC_GDP				6.6237***	4.6846***	7.4963***	6.8018***
Std. Error				0.611	1.292	1.285	0.723
p-value				< 0.0001	< 0.0001	< 0.0001	< 0.0001
Model Statistics							
Statistic	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
R-squared	0.818	0.205	0.12	0.954	0.848	0.794	0.958
Adj. R-squared	0.814	0.189	0.103	0.95	0.835	0.777	0.953
F-statistic	228.6	13.11	6.953	247.5	67.01	46.22	175.7
Prob (F-statistic)	< 0.0001	0.0007	0.0111	< 0.0001	< 0.0001	< 0.0001	< 0.0001

(Source: Author)

Table 3: *Stationary Check using ADF and KPSS*

Variable	ADF p-value	KPSS p-value	Order of Integration
Log_CO2	0.3930	0.0100	I(1)
Log_FDI	0.0633	0.0205	I(1)
log_GDP	0.9692	0.0100	I(1)
log_ TO	0.0282	0.1000	I(0)
log _Population	0.0013	0.1000	I(0)
log_Land	0.9957	0.0100	I(1)
log_EC_GDP	0.9749	0.0100	I(1)

***Note**: The sign (*) denote the significance levels: *p < 0.05, **p < 0.01, ***p < 0.001; (Source: Author)*

4.4 Unit Root test

The ADF unit root test in Table 3, the p-values of Log_CO2, Log_FDI, Log_GDP, Log_Land, and Log_EC_GDP at levels with constant only and constant and trend are above their respective critical values at all significance levels. Thus, the null hypothesis of a unit root cannot be rejected for these variables at levels. Hence, these variables are not stationary at the level.

4.5 ARDL model

This study estimates four ARDL specifications to assess both individual and combined effects of key drivers of CO_2 emissions. Models 1–3 examine EKC-related dynamics without higher-order GDP terms or controls. Lagged emissions are highly persistent, with $LOG\_CO_2(-1)$ exerting a strong positive effect (0.9439, $p < 0.01$). GDP and FDI remain statistically insignificant, offering no clear support for the EKC, PHH, or P-HH hypotheses. Trade openness shows a modest positive association with emissions (1.098, $p = 0.046$). High R^2 values (>0.97) indicate strong model performance.

This result indicates that past CO_2 levels strongly influence current CO_2 emissions. A high lag coefficient suggests continuation in emissions levels over time, a common feature in environmental studies due to the cumulative nature of emissions. This finding also validates the NZ government's concern regarding environmental emissions (Ministry for the Environment, 2023). Secondly, the coefficient for GDP (LOG_GDP) is 0.8125 and is statistically significant ($p = 0.0050$); a positive relationship between GDP and CO_2 emissions. This result

supports the initial phase of the EKC hypothesis, where economic growth initially leads to higher emissions due to increased industrial activity and energy consumption (Ali et al., 2021; Al-Mulali et al., 2016; Dogan & Turkekul, 2016; Rahman et al., 2020; Raza & Shah, 2018; Wang et al., 2024). The trend of GDP and CO2 is depicting in the same way as the ARDL model results; both shows a constant rise since 1970. However, the relatively moderate influence suggests that other factors may also affect emissions in New Zealand.

For FDI, the coefficient for net FDI inflows to New Zealand (LOG_FDI) is -0.0203, with a p-value of 0.3369, which is statistically insignificant. This result fails to validate either PHH or P-HH, which is the opposite of the findings of the impact of FDI on CO2, supporting either PHH or P-HH. Shahbaz et al. (2015) conducted the research on high, middle and low-income countries about the impact of FDI on CO2, and found that for high-income countries, P-HH hypothesis is valid, which is clearly opposite this research's results. After researching Asian countries Khan and Ozturk (2020) found the existence of PHH and a bidirectional relationship between FDI and environment. A similar type of study was conducted on 5 ASEAN countries by Zhu et al. (2016) and Guzel and Okumus (2020) also found the presence of PHH mainly due to lax environmental regulation. On the contrary, Zugravu (2017) examined the same in developed European economies like France, Germany, the UK, and Sweden. PHH is found there primarily due to lax environmental regulations, which is quite the opposite of the common consensus of developed countries.

The lack of significance of FDI to CO2 in this study suggests that New Zealand's environmental regulations may mitigate the potential negative impact of FDI on emissions (Ministry for the Environment, 2019, 2023, 2023). However, after closely looking the FDI structure of NZ this research also finds that in New Zealand FDI comes mainly in service sectors and financial sectors rather than the industrial sectors, which impact less in CO2 emissions (OECD, 2022). As service and financial sectors does not create any direct pollution.

Similarly, trade openness (LOG_TO) has a coefficient of -0.3849, and probability $p = 0.6386$. This implies that changes in trade openness may not have a direct, measurable impact on CO_2 emissions in this model. The lagged term for trade openness (LOG_TO (-1)) has a positive coefficient (1.3964) with a p-value of 0.1100. As both the results are not statistically significant this research neither accept nor rejects the hypothesis 3. However, the positive relationship could indicate that previous trade activities may have a long-term effect on emissions, which might be observed in economies with delayed environmental policies caused by trade liberalization. This finding contradicts the findings of Haider Mahmood et al. (2019), they have found a positive impact on CO2 by TO in

Tunisia, similar positive effects found by others (Frankel & Rose, 2005; Gillani & Abbas, 2023; Haug & Ucal, 2019; Rahman et al., 2020; Raza & Shah 2018). On the contrary, Al-Mulali et al. (2015) found trade openness decrease the CO2 in European nations. Similar kind of study done by Yeboah (2024) on six developed economies and found TO has mixed effects. This study includes some control variables to isolate the effects of main variables. Even after including control variables the effects of TO on CO2 in NZ is insignificant.

4.6 ARDL Bounds test and ECM test

To assess the existence of a long-run relationship, the ARDL bounds testing and error correction model (ECM) approaches are employed. The bounds test indicates the presence of a single cointegrating relationship when CO_2 emissions (LOG_CO_2) are specified as the dependent variable, with an F-statistic of 4.548 exceeding the upper critical bounds at the 10%, 5%, and 2.5% significance levels, leading to rejection of the null hypothesis of no cointegration. No evidence of cointegration is found when GDP, energy consumption, or other variables are treated as dependent variables. The ECM results further corroborate the existence of this long-run relationship.

4.7 Granger Causality test

To complete the analysis, the Granger non-causality test is conducted using the Toda-Yamamoto (TY) procedure as stated in Chapter 3. The Akaike Information Criterion (AIC) is used as the basis for the selection of the optimal lag length, following the recommendations of (J. Stock, 1994; J. H. Stock & Watson, 2015). The results for the diagnostic tests and the Granger non-causality test in this study is focused on the relationship between GDP, FDI, TO and CO2 emissions, the results relating to these variables are shown and discussed.

There are several important findings from the TY procedure. Firstly, GDP (LOG_GDP) significantly Granger-causes CO2 emissions (LOG_CO2) with a Chi-square statistic of 7.557074 and a p-value of 0.0229, suggesting that economic growth significantly predicts CO2 emissions. These results also validate the results of OLS and ARDL, by which TY Granger causality also validates the idea of EKC. On the contrary, trade openness (LOG_TO) and FDI do not impact CO2 significantly, like ARDL and OLS. However, this research could acknowledge that TO has a marginally significant effect on CO2 emissions with a Chi-square statistic of 5.500966 and a p-value of 0.0639.

For control variables, land use for agriculture (LOG_LAND) also significantly Granger-causes CO2 emissions with a Chi-square statistic of 6.796582 and a p-value of 0.0334. This finding of agricultural land conversion in NZ is important.

However, from the data set this research used clearly depicts that land conversion trend is negative for the period. For electricity consumption per GDP (LOG_EC_GDP), and urban population growth (LOG_POPULATION) these variables do not Granger-cause CO2 emissions, as indicated by their respective p-values of 0.8525, 0.1932, and 0.1177.

When considering GDP (LOG_GDP) as the dependent variable, land use (LOG_LAND) significantly Granger-causes GDP with a Chi-square statistic of 7.631782 and a p-value of 0.0220, indicating that changes in land use influence economic growth. For land use (LOG_LAND) as the dependent variable, GDP significantly Granger-causes land use with a Chi-square statistic of 16.19471 and a p-value of 0.0003, showing that economic growth influences land use changes. Additionally, energy consumption per GDP (LOG_EC_GDP) has a marginally significant effect on land use with a Chi-square statistic of 5.715707 and a p-value of 0.0574.

4.8 Examining EKC Hypothesis both OLS and ARDL

This research runs a further analysis to confirm the existence of the EKC curve in NZ for the specified period. Therefore, OLS and ARDL model were used to find the EKC. Both the conditions required the squared term of GDP, GDP*2, as prescribed in equation 2. The following discussions will show the results of the OLS and ARDL models for EKC, respectively.

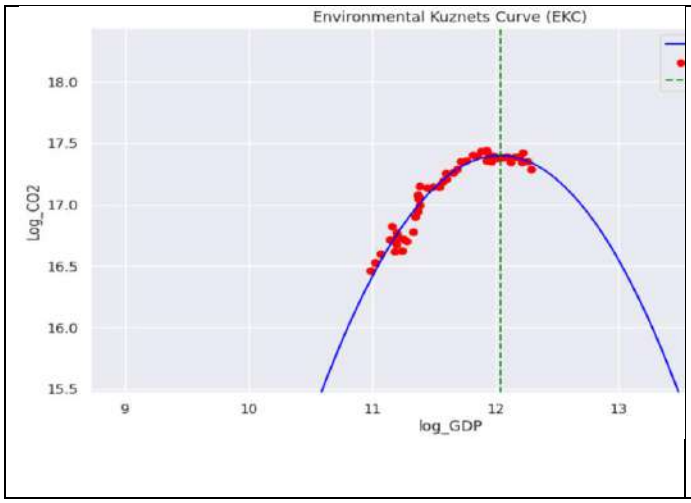

Figure 1: *EKC curve*

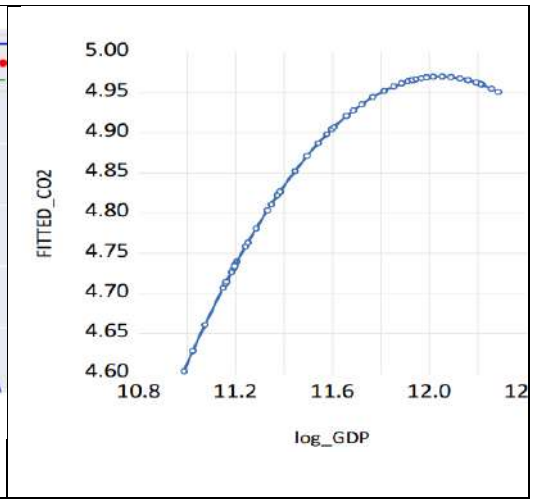

Figure 2: *EKC curve from ARDL model*

(Source: Author)

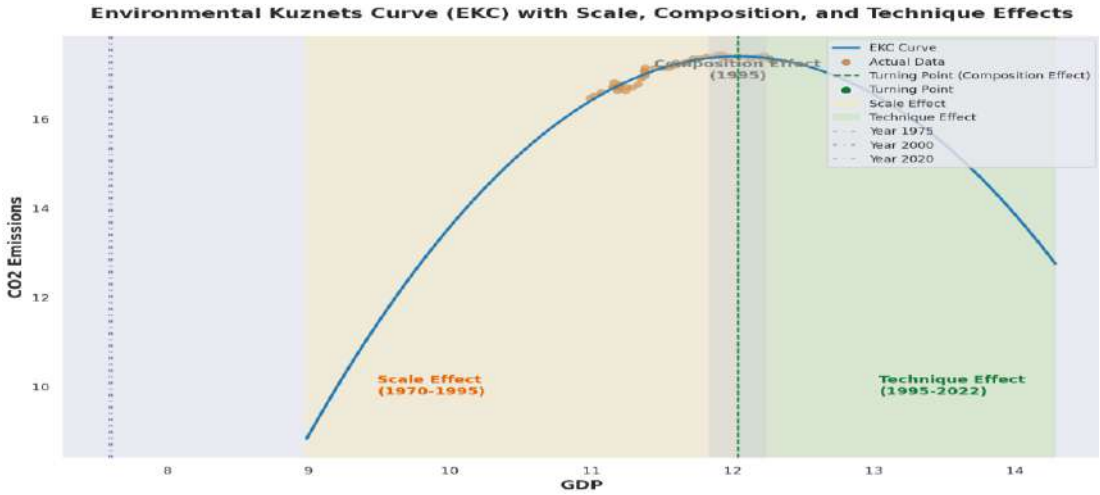

Figure 3: *EKC curve with effect* (Source: Author)

The regression results provide an Ordinary Least Squares (OLS) model results to examine the relationship between GDP and CO2 emissions in New Zealand from 1970 to 2022. The model includes a quadratic term for GDP to capture the non-linear relationship suggested by the Environmental Kuznets Curve (EKC) hypothesis (Grossman & Krueger, 1995b).

The estimated coefficients indicate a clear inverted U-shaped relationship between economic growth and CO_2 emissions. Log_GDP is positive and highly significant (22.1723; $p < 0.01$), suggesting emissions initially rise with GDP, while GDP^2 is negative and highly significant (–0.9210; $p < 0.01$), confirming the EKC hypothesis. The model explains 94.8% of the variation in CO_2 emissions (adjusted $R^2 = 0.948$), and the F-statistic (472.50; $p < 0.01$) confirms its overall significance.

Scale Effect (1970-1995) reflects how economic growth initially correlates with increasing CO_2 emissions as industries expand and resource consumption rises without substantial environmental safeguards. In New Zealand's context, rapid economic expansion in agriculture, manufacturing, and energy-intensive sectors in the 1970s through mid-1990s resulted in increased emissions (Wang, Li, et al., 2024; Wang, Wang, et al., 2024). The drive for GDP growth during this period, as evidenced globally, often prioritizes output over environmental health, amplifying emissions(Grossman & Krueger, 1995b). This effect is more noticeable in small and early industrializing economies. Recent studies further emphasize that trade protectionism can exacerbate emissions in early growth stages by discouraging environmental innovation (Bakirtas & Cetin, 2017; Wang, Li, et al., 2024; Wang, Wang, et al., 2024). However, New Zealand's geographic isolation and focus on agricultural exports mitigated some aspects of trade-related pollution shifts, seen in other nations. This stage aligns with the pollution haven

hypothesis, where economically motivated production overshadows environmental considerations.

Composition effect, 1995, from late 1980, New Zealand started significant economic reforms, moving away from high-pollution industries like manufacturing and towards cleaner sectors such as tourism, finance, and information technology. This shift aligns with the Environmental Kuznets Curve (EKC)'s Composition Effect, where a growing economy transitions to lower-emission industries. The Resource Management Act of 1991 was crucial in promoting sustainable development and setting regulatory standards that encouraged low-emission industries (Ministry for the Environment, 2023a). This legislation helped stabilize CO_2 emissions and laid the foundation for sustainable practices across various sectors

New Zealand's emissions reduction plan highlights that this economic restructuring was supported by foreign investments, which brought in cleaner technologies and practices. This aligns with the "pollution halo" hypothesis, where foreign investments lead to environmental improvements through technological advancements. As a result, New Zealand became less dependent on high-emission industries, leading to a flattening of emissions growth. This pattern is similar to what is observed in high-income countries that increasingly adopt environmental innovations (Bates, 1997; Evans et al., 1996).

Since the mid-1990s, New Zealand has pursued emission reductions through advanced technologies and robust environmental policies, exemplifying the EKC's technique effect. The 2008 Emissions Trading Scheme incentivised businesses to adopt low-emission practices, while increased use of renewable energy sources, including hydro, wind, and geothermal, lowered carbon intensity in power generation. Innovation programs, such as Vision Mātauranga, have integrated indigenous knowledge and research, supporting sustainable development. These initiatives, alongside plans to expand electric vehicle adoption and reduce fossil fuel dependence, underpin New Zealand's long-term climate strategy (MBIE, 2024; Ministry for the Environment, 2024).

4.9 Robustness check of the model

The robustness diagnostics confirm that the ARDL model is statistically sound and reliable. Residual normality is supported by the Jarque–Bera test, which fails to reject the null hypothesis ($p = 0.77$). The Breusch–Godfrey LM test indicates no evidence of serial correlation, with both F-statistic and Chi-square p-values exceeding conventional significance levels. The Breusch–Pagan–Godfrey test further confirms homoscedasticity of the residuals. Parameter stability is verified

through CUSUM and CUSUMSQ tests, which remain within the critical bounds. In addition, the Wald test confirms the joint significance of the model coefficients ($p < 0.01$). Overall, these diagnostics validate the stability, reliability, and adequacy of the ARDL specification.

Table 4: Complete table of Robustness check results (Source: Author)

Diagnostic Test	Statistic	Value	p-value	Interpretation
Serial Correlation (LM Test)	Breusch-Godfrey LM	Obs*R-squared = 0.9904	0.6094	No evidence of serial correlation
Serial Correlation (LM Test)	F-statistic	0.3565	0.7026	No serial correlation in residuals.
Heteroskedasticity Test	Breusch-Pagan-Godfrey	Obs*R-squared = 14.429	0.2742	No heteroskedasticity detected
Heteroskedasticity Test	F-statistic	1.2494	0.2875	Residuals are homoskedastic
Wald Test	F-statistic	36.7227	0.0000	Variables significantly contribute to the model.
Wald Test	Chi-square	257.0586	0.0000	Coefficients are not jointly zero.
Likelihood Ratio Test (LRE)	Lag Range (1)	LRE* Stat = 60.040	0.1341	No serial correlation
Likelihood Ratio Test (LRE)	Rao F-Stat (1)	1.2834	0.1587	Consistent with no serial correlation.
Likelihood Ratio Test (LRE)	Lag Range (2)	LRE* Stat = 111.5185	0.1656	No evidence of serial correlation
Likelihood Ratio Test (LRE)	Rao F-Stat (2)	1.1061	0.3402	
Likelihood Ratio Test (LRE)	Lag Range (3)	LRE* Stat = 224.1491	0.0000	Serial correlation present at higher lags.
Likelihood Ratio Test (LRE)	Rao F-Stat (3)	1.3213	0.2561	No significant serial correlation at lag 3.
Durbin-Watson Statistic	Model 1	2.2413	-	No autocorrelation in residuals.
Durbin-Watson Statistic	Model 2	2.0329	-	No autocorrelation in residuals.
Durbin-Watson Statistic	Model 3	2.0564	-	No autocorrelation in residuals.
Durbin-Watson Statistic	Model 4	1.9969	-	No autocorrelation in residuals.
Durbin-Watson Statistic	Model 5	2.1773	-	No autocorrelation in residuals.

4.10 FMOLS and DOLS test

Overall, the results from both FMOLS and DOLS models provide strong support for the EKC hypothesis, indicating that economic growth initially leads to higher CO2 emissions, but after reaching a certain level of GDP, further growth leads to a reduction in emissions. The results do not provide clear support for the PHH, as foreign direct investment does not significantly impact CO2 emissions. However, the significant negative impact of land use changes on CO2 emissions supports the P-HH, suggesting that better land use practices can lead to lower emissions. Moreover, the FMOLS and DOLS models provide strong support for the long-run validity and stability of the ARDL model.

5. CONCLUSIONS

The hypotheses this study examined were the EKC, PHH and P-HH, and used data from 1970 to 2022 from World Bank, WDI. This research first ran the OLS model for each variable and then combined it to isolate the effects of each and as a group on CO2 to find the EKC, PHH and P-HH in NZ. After that, the ARDL model was conducted to find the long-run and short-run relationships among the variables. The Todo Yamamoto (TY) Granger Causality test was conducted to check the causality. Then again, it ran ARDL to confirm the EKC in New Zealand. After that, all the assumptions were checked for the robustness of the model, i.e. Hateroskadasticity, normality of the residuals, and serial and multiple

collinearities. Finally, this thesis checks the stability of the model by running the FMOLS and DOLS, followed by the interpretation of results and discussion of findings.

5.1 Summary of the key findings

First, this research finds the existence of EKC in New Zealand for the said period. It also observes the unidirectional causality from GDP to CO2 emissions, which explains the notion that economic growth leads to higher CO2 levels. Moreover, the scaler effect, composition effect and technical effects are also identified by the analysis. Second, for FDI and CO2 Emissions, the lack of causality between FDI and CO2 suggests that foreign investments do not directly impact CO2 levels, which does not support the Pollution Haven Hypothesis (PHH). One of the unique findings, of this research is that neither PHH nor the P-HH hypothesis can be validated by analysing the FDI's impact on CO2 in New Zealand.

Third, Trade Openness (TO) and CO2 Emissions: The lack of causality between trade openness and CO2 emissions implies that trade activities do not directly influence CO2 levels, which does not support the Pollution Haven Hypothesis (PHH). Same as FDI, TO does not validate the idea of PHH and P-HH, which is also a unique finding of this research. This contradicts the findings of Rahman et al. (2020), they showed TO openness significantly increases CO_2 among BICM-EC member countries. Fourth, Electricity consumption per unit of GDP produced, this research does not find any strong evidence to support that EC_GDP directly increases CO2 emissions. The reason behind is that in New Zealand, majority of the electricity comes from renewable or clean sources.

Fifth, Population Growth and CO2 Emissions, the absence of causality between population growth and CO2 emissions suggests that population changes do not directly impact CO2 levels, which is quite the opposite of common findings. The consensus is that population increase also increases the CO2. However, the urban population growth in NZ is relatively stable due to the overall population growth and net outward migration from NZ, which is higher than in any other similar economy. The above findings are essential for Aotearoa to control environmental degradation by taking appropriate measures while balancing economic growth and business.

5.2 Policy implications

The empirical results reveal a unidirectional causal relationship from GDP to CO_2 emissions, supporting the existence of the Environmental Kuznets Curve (EKC) in New Zealand. This finding indicates that economic growth initially drives

emissions, underscoring the need for policy measures that sustain growth while mitigating environmental degradation, similar to the findings of other research (Dogan & Turkekul, 2016; Rahman et al., 2020; Wang, Wang, et al., 2024) . Accordingly, New Zealand should prioritise green innovation and the adoption of low-carbon technologies to decouple economic expansion from emissions. Although carbon pricing instruments, including emissions trading schemes and carbon taxes, are central to this transition, their outcomes require ongoing evaluation to ensure that environmental objectives do not impose excessive constraints on economic performance.

This research finds that foreign direct investment (FDI) does not contribute to environmental degradation in New Zealand, suggesting the absence of a pollution haven effect. As such, government policy should actively promote inward FDI. New Zealand ranks 48th among 180 economies in terms of FDI inflows, indicating substantial scope to attract greater levels of environmentally responsible investment (World Population Review, 2023).

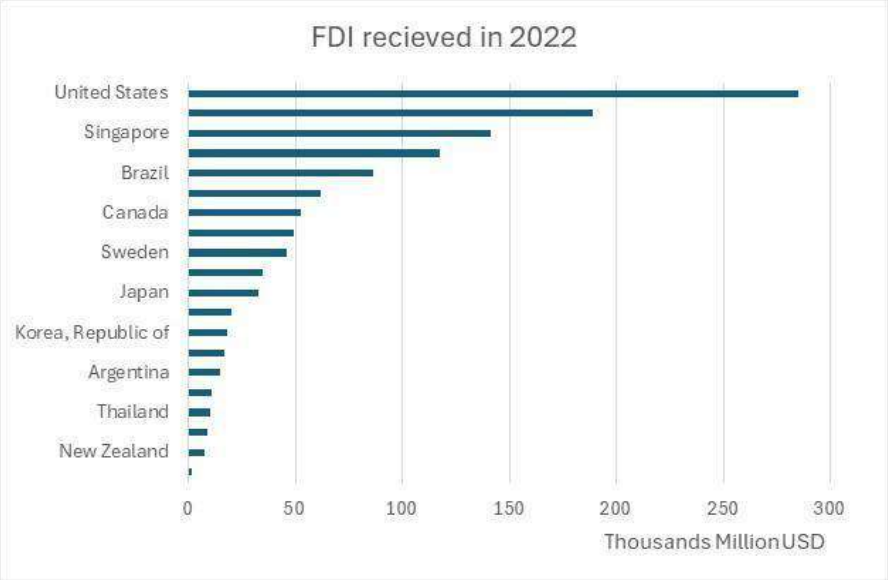

Figure 4: *FDI stock ranking by country*
Source: Adoption from data (World Population Review, 2023)

In addition, conversion to agricultural land is found to Granger-cause CO_2 emissions, with a reciprocal relationship observed between land use and GDP. This result emphasises the importance of sustainable land management in emissions reduction. Given the significant emissions associated with land-intensive primary industries, New Zealand should progressively diversify towards less land-dependent sectors. The adoption of efficient land-use practices,

energy-efficient agricultural technologies, and sustainable urban planning can further reduce land-related emissions.

Finally, the interaction between economic activity, energy efficiency, and population growth highlights the need for sustainable urbanisation strategies. Investment in low-emission urban infrastructure and more decentralised development can accommodate population growth while minimising environmental pressures. Overall, strengthening awareness and implementing actionable sustainability measures remain critical to reducing environmental degradation and supporting long-term economic resilience in New Zealand.

5.3 Limitations of the study

This research has several limitations. First, the analysis is based on data from 1970 to 2022, providing 53 observations. While this sample size is still larger than other studies (which often range from 30 to 40 observations)(Al-Mulali et al., 2016; Rahman et al., 2020b, 2020d; Villanthenkodath & Arakkal, 2020c). Third, while this thesis confirmed an inverted U-shaped relationship between GDP and CO2 emissions, confirming the Environmental Kuznets Curve (EKC) hypothesis, it is limited by the reduced-form models used. These models do not provide insights into the mechanisms by which GDP influences CO2 emissions (Grossman & Krueger, 1995b).

5.4 Opportunities for Future Research

Based on the findings and limitations of this thesis, several avenues for future research are recommended: future models could help avoid model misspecification by considering the complex interdependencies within the GDP-FDI-TO-CO_2 nexus. For instance, even if positive causality exists from energy consumption (EC) to GDP, heavily indebted economies may not experience GDP growth as expected if the energy infrastructure is funded by international investments, thus distorting the causal relationships. Future studies could apply ML algorithms to capture more complexity, incorporate dynamic forecasting and intertemporal causality analysis to understand better short-run and long-run relationships.

The most important aspect of this study is its comprehensive methodological approach, which goes beyond the traditional use of single econometric techniques commonly applied in EKC research. Unlike many earlier studies, this research employs a combination of OLS, ARDL, FMOLS, DOLS, and Toda–Yamamoto Granger causality methods to ensure robustness and reliability of the results. This multi-method framework allows for cross-validation of long-run and short-run relationships and provides stronger empirical evidence by addressing issues such

as endogeneity, small sample bias, and dynamic interactions among variables. As a result, the study contributes to the literature by offering a more rigorous and comprehensive analysis, which enhances the credibility of the findings and provides more reliable insights for environmental and economic policy.

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Awareness about Carbon Footprint and its Impact on Cross-border Online Shopping Behaviour in New Zealand

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ABSTRACT

Carbon footprint emissions are widely recognised as a major threat to environmental sustainability and a key contributor to climate change. With the rapid expansion of technology, globalisation, and the acceleration of e-commerce during the COVID-19 pandemic, concerns regarding the environmental impact of cross-border online shopping have intensified. This study examines awareness of carbon footprint and its influence on cross-border online shopping behaviour in New Zealand, where overseas e-commerce activity has grown significantly in recent years. The research investigates differences in carbon footprint awareness across demographic factors and explores the relationships among awareness, sustainability-related attitudes, and purchasing behaviour. The findings reveal a generally high level of carbon footprint awareness among New Zealand consumers, with significant variations observed across age and income groups. Carbon footprint awareness is shown to significantly influence attitudes and behavioural intentions toward cross-border online shopping. Additionally, positive correlations are identified between awareness of environmental consequences, environmentally conscious behaviour, and online purchasing decisions. The results suggest that sustainability considerations increasingly shape consumer choices, with many shoppers taking environmental impacts into account before making cross-border purchases, highlighting the importance of integrating environmental awareness into e-commerce strategies and policy development.

Keywords: *Carbon Footprint, Carbon footprint awareness, Carbon footprint awareness in New Zealand, cross-border online shopping*

1. INTRODUCTION

Sustainability has become one of the major focus areas for organizations as developments in technology advancements and shifts in business environments emerged globally. With this, the rise in carbon footprints gained attention for being a significant contributor to climate change thus negatively affecting environmental sustainability. Carbon footprints result from emissions from various human activities involved in electricity consumption, transportation, shopping, food consumption, and use of digital technologies. It is the overall

amount of greenhouse gas emissions caused by the consumption of energy or electricity (Growcom, 2008).

Amplified by the Covid-19 pandemic, the global community has seen a significant increase in online shopping activities. The pandemic fuelled a growth in digitisation which triggered a shift in the purchasing behaviours of consumers, specifically in terms of online shopping or E-Commerce. In New Zealand, a country that implemented major lockdowns and restrictions during the Covid-19 pandemic, there was a significant growth experienced in the E-Commerce landscape (Statista Research Department, 2024). Post-pandemic, New Zealand is expected to continuously experience growth in the E-commerce sector (Commission Factory, 2023).

The boost in online shopping activities also triggered debates and led to gaining of traction of carbon footprint implications caused by the whole online shopping cycle which covers manufacturing, packaging, logistics, and digital technology usage. In terms of carbon footprint impact, cross-border E-commerce is reported to generate more carbon emissions than domestic delivery considering the longer supply chain process (Nakamichi et al., 2016).

This study focuses on the concept of carbon footprint and its influence on cross-border online shopping. It aims to determine the level of awareness about carbon footprints and to assess if there are significant differences in the awareness levels according to factors such as gender, age, education background, income level, and online shopping frequency. Moreover, the study intends to examine the relationships among carbon footprint awareness level, and the attitude and behaviour towards cross-border online shopping. Furthermore, the study aims to identify and analyse other sustainability-related factors that affect the purchasing behaviour of consumers in terms of cross-border online shopping.

1.1 Carbon Footprint

Carbon footprint is the overall emission of Greenhouse Gases (GHG), which trap heat in the atmosphere and come from different contributors such as households, industries, food, electricity, and transportation (Environmental Protection Agency, 2023). GHG include Chlorofluorocarbons, Methane, Nitrous Oxide, and Carbon Dioxide (Britannica, n.d.). Carbon Footprint stemmed from the notion of "ecological footprint" (Ercin & Hoekstra, 2012) which refers to the measure of environmental resources required to support any activity or lifestyle (Eco Online, n.d.). These are usually expressed in tons of carbon generated during an activity, process, or period by an organization or individual (Harkiolakis, 2013).

1.2 Cross-Border Online Shopping

Consumers participate in online shopping using digital devices, websites, and online marketplaces. In New Zealand, a significant growth in online shopping behaviour was reported, which was mainly driven by the shift in purchasing behaviours caused by the Covid-19 social distancing measures and lockdowns (IBIS World, 2023). This entails expected increase of online shopping users and activities in the country in the coming years.

Alongside the surge in the popularity of E-commerce comes cross-border E-commerce which refers to international transactions where sellers and buyers from different countries participate in online transactions (Xue et al., n.d.). In a typical E-commerce cycle, the online consumers use the Internet for various purposes including browsing for product details and reviews, placing orders, proceeding with checkout and payment (Sinha & Kim, 2012). Meanwhile, from the vendors' end, activities include manufacturing or provisioning of the products or services, packaging the sold items for shipment, and transporting the goods to the destination. These activities involve consumption of goods and usage of technologies and various transportation methods. These result to carbon emissions, contributing to the increase of carbon footprints. In comparison to domestic online shopping, the end-to-end supply chain operations are considered more complex, and distance involved is typically longer, resulting to more carbon emissions and larger footprints (Jeroschewsk, 2015).

In New Zealand, cross-border online shopping is considered as a growing market, boosted by the Covid-19 pandemic where shift in the purchasing behaviour of shoppers was observed. International shopping is considered well-known in New Zealand as it involved a spending of more than $250 million among the country's residents. This is evident from the surge in various E-commerce businesses such as Temu and Shein and marketplaces such as Amazon, AliExpress, and ASOS (Eurotext Redaktion, 2023). Online shoppers typically participate in cross-border E-commerce due to lower prices (Frederick, 2015) and variety of product options.

1.3 Problem Statement

The rise in online shopping activities in New Zealand entail an increase of carbon footprint in the ecosystem, considering the growth in consumption of goods, requirement of energy use from human and commercial activities, and additional packaging materials which likely end up in the landfill, contributing to emissions. The implications brought about by carbon footprint can be exacerbated through participating in cross-border online shopping activities due to the involvement of more fulfilment activities than domestic E-commerce.

As E-commerce activities which include cross-border online shopping in New Zealand are expected to further grow (ECDB, n.d.), it is imperative to investigate the status of the awareness about the concept of carbon footprints in conjunction with online shopping to expand the research landscape in this subject area. Currently, in New Zealand, there is a limited number of available studies which delve on the awareness level about carbon footprint of online consumers concerning cross-border online shopping.

1.4 Research Objectives

The study focuses on the concept of carbon footprint and its influence on cross-border online shopping. It aims to identify the level of awareness about the concept of carbon footprint and to assess if there are significant differences in the awareness levels according to various factors such as gender, age, education, income level, and online shopping frequency. Also, the study intends to examine the relationships among the awareness level about carbon footprint with the attitude and behaviour towards cross-border online shopping and to analyse the impact of awareness about carbon footprint towards the behaviour of consumers in New Zealand, in terms of cross-border online shopping. Furthermore, the study aims to analyse other sustainability-related factors that influence the purchasing behaviour of consumers in terms of cross-border online shopping.

1.5 Research Questions

The study aims to provide answers to the following questions:

RQ 1: To what extent are online shoppers in New Zealand aware in terms of the concept of carbon footprint?

RQ 2: Are there significant differences in the awareness levels according to:

- Gender
- Age
- Education
- Income Level
- Online Shopping Frequency

RQ 3: What are the relationships among level of awareness about carbon footprint and the attitude and behaviour towards cross-border online shopping among online shoppers in New Zealand?

RQ 4: Does awareness about carbon footprint impact the cross-border online shopping behaviour of online consumers in New Zealand?

RQ 5: What are the environmental sustainability-related factors that influence cross-border online shopping behaviour and how does these impact online consumers' purchasing behaviour?

1.6 Significance of the Study

The study has the potential to raise awareness about the notion of carbon footprints in New Zealand. It may provide insights to businesses regarding customers' perception on online shopping and cross-border E-commerce, in the context of carbon footprint or sustainability. Also, the study can provide insights to businesses in terms of the development and execution of corporate social responsibility initiatives. Furthermore, the findings from the study can potentially encourage education, initiatives, and employment of carbon footprint management practices among online shoppers, businesses, and organizations to deliver a positive contribution to environment and promote sustainability.

2. LITERATURE REVIEW

2.1 Awareness about Carbon Footprint

The concept of carbon footprint is believed to have gained popularity due to environmental concerns linked to the increase in carbon emissions present in the atmosphere. It originated from the notion of ecological footprint and evolved into a standalone concept. With this, different views concerning the naming convention and definition of the term "carbon footprint" exist due to the scope of the gases involved and the suitability of the measurement unit to be utilised for the coverage of the carbon emissions. In terms of naming convention, differing perspectives are present such as the incorrectness of the measurement unit in tons as the word "footprints" indicates spatial characteristics which implies that "carbon weight" is a better term as it is measured in tons (Hammond, 2007) and the better applicability of using "climate footprint" as it measures other Carbon Dioxide alternatives (Wiedmann & Minx, 2008).

The term "carbon footprint" is described differently by various institutions as it does not have a standard academic definition. It is described as a measure of the whole Carbon Dioxide emissions that may be directly or indirectly generated by cumulative activities involved in the production of goods or services (Durojaye et al., 2020). Similarly, carbon footprint is referred to as an estimate of the Carbon Dioxide emissions during fossil fuel combustions (Grubb & Ellis, 2007). However, only direct emissions related to the manufacturing of the products or outputs encompasses carbon footprints hence indirect emissions are excluded (Carbon Trust, 2007). Likewise, the defined scope of carbon footprint has also evolved over time. From solely recognising Carbon Dioxide emissions, numerous organizations have shifted to including Carbon Dioxide equivalents or

other GHG into the scope as well. Carbon footprint is also referred to as the total amount of emissions of Carbon Dioxide and its equivalents or other GHG from outputs (Center for Sustainable Systems, University of Michigan, 2023; Selin, 2024).

Despite the views surrounding the concept of carbon footprint, it is utilized and acknowledged similarly in different fields such as the academe, government, and commercial sectors. Generally, it involves carbon emissions which are harmful to the atmosphere and contribute to climate change.

By highlighting carbon footprint as a crucial factor in sustainability and environmental protection, the public is made more aware regarding its implications and consequences. This core message raised awareness about carbon footprints in different sectors and audience. It is crucial that the current status of awareness is further examined to have a general understanding of the public's perspective regarding carbon footprints. Based on previous studies, mostly focused on geographical locations and the education sector, variations in the status of awareness among different categories are observed. In a certain country, a general level of awareness is displayed by the majority of the respondents, however, an understanding on how to act upon it is lacking (Wu & Yang, 2011). This displays that there may be a gap between the awareness level and the behaviour in addressing the sustainability issue concerning carbon footprints. As for students, low level of awareness is observed among most postgraduate students in a university and differences in the awareness of level are observed between male and female students (Dash et al., 2023). In other cases, different groups of students exhibited varying status of awareness about carbon footprint as findings showed limited level (Öz-Aydin, 2016) and high level of awareness (Hayder et al., 2018) for different studies.

2.2 Knowledge-Attitude-Behaviour (KAB) Framework

According to the KAB framework, Knowledge, Attitude, and Behaviour are considered crucial aspects of behavioural change. Knowledge includes every bit of information that an individual possesses about a subject (Alexander & Jetton, 2000). It can also be defined as "an individual's interpretation of information based on personal experiences, skills, and competencies" (Bollinger & Smith, 2001). While knowledge is about the comprehension of a subject or ideas, *awareness*, on the other hand, pertains to the consciousness about an idea or a new trend (Alordiah et al., 2023). The two concepts can be interlinked with each other. In the context of the stages of the Diffusion of Innovation, *awareness-knowledge* (as part of the knowledge state) is one of the specified forms of knowledge where it implies that awareness is a form of knowledge that establishes the existence of the idea. This knowledge type helps to motivate individuals to know more about the subject and adopt it afterwards. This also

affects the individual's motivation to learn more about the other types of knowledge: how-to and principles knowledge (Rogers, 2003). With this, awareness is considered a scope of knowledge and denotes knowledge.

Attitude can be understood as the way an individual views or evaluates a subject or a situation (Vargas-Sánchez et al., 2016). According to Allport (1967), attitude can be defined, from a behavioural context, a mental state of readiness conditioned by a stimulus that is regulating a response to the relevant subject or object. Attitudes are believed to be triggered before doing decision-making in the overall behavioural process and is considered as a good predictor of behaviour (de Boer et al., 2007, as cited in Rondoni & Grasso, 2021).

Meanwhile, behaviour can be simply referred to as an action that can be observed. It is the way an individual reacts to a particular condition (Schrader & Lawless, 2004). It indicates actions that are related to the knowledge and attitude of individuals considering that these actions are consistent with the understanding, beliefs, and other social activities or processes (Heimlich & Ardoin, 2008).

The study applies the KAB framework in assessing the relationships among the level of awareness about carbon footprint and the attitude and behaviour towards cross-border online shopping of consumers. The study presumes that awareness or knowledge is required for behavioural change (Hungerford & Volk, 1990) and affects the behaviour for individuals hence measuring of awareness level is deemed vital to explore the relationship between carbon footprint awareness and behaviour towards cross-border online shopping, a carbon-intensive activity. Based on previous studies, strong influence of awareness to the customers' behaviour was observed (Aaker & Day, 1974) and specifically from an environmental awareness perspective, a positive relationship between the two components has also been exhibited (Kikuchi-Uehara et al., 2016; L. Zhang & Zhou, 2016).

The KAB model illustrates that behaviour is determined by the attitude of an individual towards the practice or behaviour itself (Launiala, 2009) and attitude towards behaviour is influenced by knowledge and awareness. This model originated from Roger's Diffusion of Innovation Theory (Rogers, 2003) and Learning Theory (Bandura, 1971) which gives light to the relationships between the three components. The KAB framework implies that all of the aspects are interrelated with each other and are all considered vital in influencing changes (Zakwan et al., 2022).

2.3 Sustainability-related factors that influence cross-border online shopping behaviour

In the context of sustainability and green behaviour, a known phenomenon called attitude-behaviour gap exists in various studies exists (Grandin et al., n.d.; Newton & Meyer, 2013; Tam & Chan, 2017). This concept implies that there is an inconsistency between the two components where high level of attitude does not always translate to pro-environmental behaviour (Wang et al., 2022). Considering this, exploring other sustainability-related factors is intended to support the attitude-behaviour gap within the context of online shopping behaviour. Awareness of negative consequences and environmentally conscious behaviour are found to be influencing factors of cross-border online shopping behaviour (Backhaus et al., 2011, as cited in Schleiden & Neiberger, 2020). Awareness of negative consequences of cross-border online shopping covers the negative environmental impacts contributed in terms of energy consumption, resources depletion, and pollution (Tiwari & Singh, 2011). For cross-border E-commerce, this includes increase in the generation of freight traffic due to international trades which leads to environmental impacts from pollution and emissions (Zanker, 2018, as cited in, Schleiden & Neiberger, 2020).

Meanwhile, environmentally conscious behaviour pertains to a psychological behaviour that involves inclination to participate in eco-friendly activities (Zelezny & Schultz, 2000). This involves willingness to know environmental issues, support initiatives to combat environmental concerns, and act to contribute solutions (Lin & Chang, 2012). Although this term is defined in different ways, environmental consciousness mainly denotes an eco-friendly consumption behaviour.

2.4 Research Hypotheses

The research hypotheses below are formulated to provide answers to the research questions:

Hypothesis 1: *There is a significant difference in the level of awareness about carbon footprint of online shoppers according to gender.*

Hypothesis 2: *There is a significant difference in the level of awareness about carbon footprint of online shoppers according to age.*

Hypothesis 3: *There is a significant difference in the level of awareness about carbon footprint of online shoppers according to education.*

Hypothesis 4: *There is a significant difference in the level of awareness about carbon footprint of online shoppers according to income level.*

Hypothesis 5: *There is a significant difference in the level of awareness about carbon footprint of online shoppers according to online shopping frequency.*

Hypothesis 6: *Awareness about carbon footprint has a significant influence on the cross-border online shopping attitude of online consumers in New Zealand.*

Hypothesis 7: *Attitude has a significant influence on the behaviour towards cross-border online shopping of online consumers in New Zealand.*

Hypothesis 8: *Awareness about carbon footprint has a significant influence on the cross-border online shopping behaviour of online consumers in New Zealand.*

Hypothesis 9: *Awareness of negative consequences has a significant and positive influence on cross-border online shopping behaviour.*

Hypothesis 10: *Environmentally conscious behaviour has a significant and positive influence on cross-border online shopping behaviour.*

3. RESEARCH METHODOLOGY

Empirical methods and quantitative analysis were utilised to examine the relationships among the factors and variables involved in this research. Information relevant to the study was collected and interpreted in an objective manner as aligned with positivism that relies to the view that the knowledge based on facts which is gained through observation can be trusted (Saunders et al., 2020).

Several hypotheses that are aligned with the subject areas: awareness about carbon footprint and its influence on the cross-border online shopping behaviour among New Zealanders, and an existing framework were developed and tested. A deductive approach was employed which involves developing and testing of hypotheses (Saunders et al., 2020) and implies that the conclusion will be logically based on theory-based premises (Ketokivi & Mantere, 2017). This led to findings and conclusion that are solely based on the valid outcome of the analysis.

The research employed a quantitative method to determine the awareness level and its various impact to the online shopping behaviour of consumers who participate in cross-border E-commerce via an online survey. Survey questionnaire was used to gather first-hand responses from the sample.

3.1 Data Collection Method

A questionnaire via an online survey was distributed to enable the collection of data for this study. An online form was created and distributed to a sample of 387 respondents which contained a set of thirty questions. These were categorized into five different sections. The first section involved questions about the respondents' demographic information while the rest employed Likert scale questions. A Likert Scale of 1 to 5 was used, which was comprised of Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, and Strongly Disagree. Likert scales are often used to measure beliefs, perceptions, and attitude toward a subject (Bertram, 2006). This caters to measuring of variables that cannot be directly observed hence self-report assessments are made through rating scales (Alkharusi, 2022).

3.2 Data Analysis

Necessary data preparation step and data cleaning were conducted to ensure that the responses are free from inconsistencies and error. The collected data was tabulated using the software tool, IBM SPSS Statistics, for analysis.

3.3 Results

3.3.1 Analysis of Carbon Footprint Awareness Level

A five-point Likert Scale was utilized for the study and was included in the survey questionnaire. Likert Scale Analysis is typically done through evaluating a composite score such as mean or sum of Likert Scale items. Measuring the mean for central tendency through descriptive statistics is one of the recommended methods of analysis (Boone & Boone, 2012). Likert Scale was used to measure the views of the respondents to the questions under Awareness, Attitude, Sustainability-Related Factors, and Behaviour categories.

The corresponding scores for each of the Likert scale degree are as follows: 1 for Strongly Disagree, 2 for Disagree, 3 for Neither Agree nor Disagree, 4 for Agree, and 5 for Strongly Agree. The mean scores of the collected responses using the delegated weight for the Likert scale questions were evaluated to measure carbon footprint awareness level.

Three evaluation criteria were used to define the level of the score derived from the analysis. The range of 1 to 2.33 indicates a low-level score while 2.34 to 3.66 and 3.67 to 5 are equivalent to medium-level and high-level scores, respectively.

As shown in Table 1, a high level score is consistent across all items including the overall mean score of the entire Awareness category. Awareness category got an overall mean score of 3.94 which is considered high based on the range criteria, indicating a high level of awareness about carbon footprint.

Table 1: Summary of the Result of the Likert Scale Analysis

Question No.	Statement	Mean	Interpretation
Q1	I am aware about the term "Carbon Footprint".	3.97	High Level
Q2	I know the definition of the term "Carbon Footprint".	3.88	High Level
Q3	I am aware that carbon footprint has environmental implications and contributes to climate change.	4.08	High Level
Q4	I am aware that human and commercial activities result to an increase in carbon footprints.	4.09	High Level
Q5	I am aware that my own online shopping activities result to an increase in carbon footprints.	3.78	High Level
Q6	I am aware that the transportation activities involved in delivering or shipping my purchases contribute to carbon emissions.	4.01	High Level
Q7	I am aware that the packaging materials for my purchased products and goods contribute to carbon emissions.	3.98	High Level
Q8	I am aware that my online shopping activities which involve usage of digital devices such as smartphones, tablets, and the Internet contribute to carbon emissions.	3.80	High Level
Q9	I am aware that cross-border (overseas) online shopping may result to more carbon footprints than domestic (local) online shopping.	3.87	High Level
	Overall Score	***3.94***	***High Level***

Note. This table demonstrates the mean score and interpretation of each item from the Awareness category. (Source: Author)

3.3.2 Hypothesis Testing Results

A) T-test

H1: There is a significant difference in the level of awareness about carbon footprint of online shoppers according to gender.

Independent sample T-test is often used to identify significant differences between two unrelated variables where the mean score of two unrelated variables or groups are tested (Ross Amanda & Willson, 2017). T-test was utilized to identify significant differences between gender groups for this study. Respondents are categorized into three groups based on the collected responses: Female, Male, and Undisclosed. However, due to the small count of the respondents under the undisclosed group, the undisclosed sample is removed specifically for this hypothesis test.

Based on the independent samples t-test result as shown in Table 2, there are no significant differences between the mean scores of Female and Male. This implies that Hypothesis 1 is not valid.

Table 2: Summary of the result of Awareness Level according to gender

Levene's Test for Equality of Variances						
Gender	**Mean**	**SD**	**F**	**Sig.**	**t**	**df**
Female	3.9979	.59755	.839	.360	1.448	379
Male	3.9017	.69915				

Group Differences					
Gender	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval (LB – UB)**	
Female - Male	0.148	.09610	0.06643	-.03443	.22681

Note. This table demonstrates the t-test result to detect significant differences in the carbon footprint awareness level according to gender; (Source: Author)

B) One-way ANOVA

H2*: There is a significant difference in the level of awareness about carbon footprint of online shoppers according to age.*

One-Way ANOVA was used to determine significant differences between the specified groups for Hypotheses 1 to 5. ANOVA is a statistical test that is used to check the differences among three or more groups or variables. It compares the variance estimates (King, 2010) and is used to determine if there is a difference

in means among groups without having the need to use multiple t-test (DeJarnette & Mamidala, 2023). Post hoc tests were also employed to check the differences in between specific groups. Dunnett and Tukey Tests are utilized to perform further comparison and determine where the significant differences lie for each variable pairing (Shingala & Rajyaguru, 2015).

As shown in Table 3, the level of awareness across the age groups is significantly different. Equal variance was assumed due to the insignificance of the Levene's Statistic. To assess the individual differences between each group, post-hoc tests were checked using Tukey HSD. Based on the result, the mean score for the age group of 26 to 35 years old was significantly different from the 36 to 45 years old group while the rest of the age groups did not vary significantly from each other.

Table 3: Summary of the result of Awareness Level according to age

			Test of Homogeneity of Variances		ANOVA			
Age Range	**Mean**	**Std. Deviation**	**Levene's Statistic**	**Sig.**	**df1**	**df2**	**F**	**Sig.**
18 to 25 years old	3.8873	0.67532	1.301	.269	4	382	3.853	.004
26 to 35 years old	4.065	0.54787						
36 to 45 years old	3.8201	0.76195						
46 to 60 years old	3.7204	0.71138						
61 and above	4.2063	0.39767						

Group Differences				
Age Range	**Mean Difference**	**Sig.**	**95% Confidence Interval (LB – UB)**	
26 to 35 years old - 36 to 45 years old	.24492	.044	.0038	.4861
26 to 35 years old - 46 to 60 years old	.34460	.130	-.0538	.7430
46 to 60 years old - 61 and above	-.48592	.202	-1.1163	.1444
36 to 45 years old - 61 and above	-0.38624	.305	-0.9778	.2053
26 to 35 years old - 18 to 25 years old	0.17777	.426	-0.0843	.4399
61 and above - 18 to 25 years old	0.31909	.525	-0.2743	0.9124
18 to 25 years old - 46 to 60 years old	0.16682	.954	-0.2746	0.6082
46 to 60 years old - 26 to 35 years old	0.14132	0.975	-0.4534	0.736
36 to 45 years old - 46 to 60 years old	0.09968	0.999	-0.3314	0.5307
18 to 25 years old - 36 to 45 years old	0.06715	1.0	-0.2468	0.3811

Note. This table demonstrates the ANOVA result to detect significant differences in the carbon footprint awareness level of respondents according to age: (Source: Author)

Hypothesis 3: ***There is a significant difference in the level of awareness about carbon footprint of online shoppers according to education.***

As shown in Table 4, there is no significant difference in the level of awareness among the respondents according to their highest educational attainment.

Table 4: Summary of the result of Awareness Level according to education

Test of Homogeneity of Variances					ANOVA			
Highest Educational Attainment	**Mean**	**Std. Deviation**	**Levene's Statistic**	**Sig.**	**Df1**	**Df2**	**F**	**Sig.**
No Qualification	4	0.0000	2.482	.031	5	381	1.560	.170
Secondary School Level	3.7280	0.40780						
Bachelor's Degree	3.9534	0.76227						
Post-Graduate Degree	3.8497	0.58745						
Master's degree	4.0207	0.55932						
Doctorate Degree	3.3333	0.47140						

Note. This table demonstrates the ANOVA result to detect significant differences in the carbon footprint awareness level of respondents according to highest educational attainment; (Source: Author)

Hypothesis 4: ***There is a significant difference in the level of awareness about carbon footprint of online shoppers according to income level.***

The range NZD 200001 and above was removed for this testing as there was no response received for the specified group. As shown in **Table 5**, the level of awareness across different income level groups are significantly different.

Equal variance was assumed due to the insignificance of the Levene's Statistic. To assess the individual differences between each group, post-hoc tests were checked using Tukey HSD. Based on the result, if groups are compared with each other individually, the existence of significant difference varies.

Table 5: *Summary of the result of Awareness Level according to income level*

	Test of Homogeneity of Variances				ANOVA			
Income Level	**Mean**	**Std. Deviation**	**Levene's Statistic**	**Sig.**	**df1**	**df2**	**F**	**Sig.**
No Income	3.7238	0.79197	.991	.431	6	380	2.428	.026
$1 to $5,000	3.8781	0.56476						
$5,001 to $10,000	4.1111	0.50512						
$10,001 to $50,000	4.0538	0.61825						
$50,001 to $75,000	3.9942	0.6854						
$75,001 to $100,000	3.9249	0.71485						
$100,000 to $200,000	3.9731	0.60094						

Group Differences				
Income Level	**Mean Difference**	**Sig.**	**95% Confidence Interval (LB – UB)**	
$10,001 to $50,000 - No income	.33003	0.022	0.0285	0.6316
$5,001 to $10,000 - No income	.38730	0.044	0.0062	0.7684
$50,001 to $75,000 - No income	0.27034	0.374	-0.1171	0.6578
$5,001 to $10,000 - $1 to $5,000	0.23302	0.534	-0.1462	0.6122
$100,000 to $200,000 - No income	0.24925	0.536	-0.1568	0.6553
$10,001 to $50,000 - $1 to $5,000	0.17575	0.588	-0.1234	0.4749
$75,001 to $100,000 - No income	0.20112	0.729	-0.1897	0.5919
$1 to $5,000 - No income	0.15428	0.793	-0.1685	0.477
$5,001 to $10,000 - $75,001 to $100,000	0.18619	0.87	-0.2524	0.6248
$10,001 to $50,000 - $75,001 to $100,000	0.12891	0.947	-0.2426	0.5005
$5,001 to $10,000 - $100,000 to $200,000	0.13805	0.972	-0.3141	0.5902
$50,001 to $75,000 - $1 to $5,000	0.11607	0.974	-0.2695	0.5016
$5,001 to $10,000 - $50,001 to $75,000	0.11696	0.985	-0.3186	0.5525
$100,000 to $200,000 - $1 to $5,000	0.09498	0.993	-0.3092	0.4992

$10,001 to $50,000 - $100,000 to $200,000	0.08077	0.996	-0.3067	0.4683
$5,001 - $10,000 - $10,001 - $50,000	0.05727	0.999	-0.304	0.4186
$10,001 to $50,000 - $50,001 to $75,000	0.05969	0.999	-0.3083	0.4277
$50,001 to $75,000 - $75,001 to $100,000	0.06923	0.999	-0.3749	0.5133
$50,001 to $75,000 - $100,000 to $200,000	0.02109	1	-0.4364	0.4786
$75,001 to $100,000 - $1 to $5,000	0.04684	1	-0.3421	0.4358
$100,000 to $200,000 - $75,001 to $100,000	0.04814	1	-0.4123	0.5085

Note. This table demonstrates the ANOVA result to detect significant differences in the carbon footprint awareness level of respondents according to income level; (Source: Author)

Hypothesis 5: ***There is a significant difference in the level of awareness about carbon footprint of online shoppers according to online shopping frequency.***

As shown in Table 6, there is no significant difference in the level of awareness among the respondents according to their online shopping frequency.

Table 6**:** *Summary of the result of Awareness Level according to online shopping frequency*

			Test of Homogeneity of Variances				ANOVA	
Online Shopping Frequency	**Mean**	**Std. Deviation**	**Levene's Statistic**	**Sig.**	**df1**	**df2**	**F**	**Sig.**
Daily	4.1111	1.25708	1.145	.335	6	380	.544	.775
2 to 3 times per week	3.9630	0.61435						
Once a week	3.8660	0.44594						
2 to 3 times per month	3.9187	0.66312						
Once a month	4.0320	0.59589						
2 to 5 times per year	3.9705	0.66733						
Once a year	3.8639	0.76409						

Note. This table illustrates the ANOVA result to detect significant differences in the carbon footprint awareness level of respondents according to online shopping frequency; (Source: Author)

C) Regression Analysis

Regression analysis is often used for exploring the association between variables. It determines the impact and measures the strength of the influence of an independent variable on a dependent variable. It also helps to calculate if an independent variable has a significant influence on a dependent variable (Sarstedt & Mooi, 2019). This is used for hypotheses 6 to 8.

Hypothesis 6: ***Awareness about carbon footprint has a significant influence on the cross-border online shopping attitude of online consumers in New Zealand***.

As shown in Table 7, AW is a significant predictor of ATT which implies that AW has a significant influence on ATT.

Table 7: *Summary of the result to check significant influence of AW on ATT*

Hypothesis	Regression Weights	Beta Coefficient	R^2	df1	df2	F	p-value	Does this support the hypothesis?
H6	AW ATT	0.667	0.427	1	385	286.607	<.001	Yes

*Note. *p < 0.05. AW: Awareness Level about Carbon Footprint, ATT: Attitude towards cross-border online shopping; (Source: Author)*

Hypothesis 7: ***Attitude has a significant influence on the behaviour towards cross-border online shopping behaviour of online consumers in New Zealand.***

As shown in Table 8, ATT is a significant predictor of BHVR which implies that ATT has a significant influence on BHVR.

Table 8: Summary of the result to check significant influence of ATT on BHVR

Hypothesis	Regression Weights	Beta Coefficient	R^2	df1	df2	F	p-value	Does this support the hypothesis?
H7	ATT BHVR	0.550	0.20	1	385	96.099	<.001	Yes

*Note. *p < 0.05. ATT: Attitude towards cross-border online shopping, BHVR: Behaviour towards cross-border online shopping; (Source: Author)*

Hypothesis 8: ***Awareness about carbon footprint has a significant influence on the cross-border online shopping behaviour of online consumers in New Zealand***.

As shown in Table 9, AW is a significant predictor of BHVR which implies that AW has a significant influence on BHVR.

Table 9: Summary of the result to check significant influence of AW on BHVR

Hypothesis	Regression Weights	Beta Coefficient	R^2	df1	df2	F	p-value	Does this support the hypothesis?
H8	AW BHVR	0.333	0.070	1	385	29.140	<.001	Yes

*Note. *p < 0.05. AW: Awareness Level about Carbon Footprint, BHVR: Behaviour towards cross-border online shopping; (Source: Author)*

D) Correlation Analysis

Correlation analysis is a technique that is used to examine the significance of the relationships of variables. Statistical significance and the direction of the relationship between variables are tested and determined (Prematunga, 2012). This study used Pearson correlation to perform the analysis of the various variables concerning environmental sustainability-related factors. A sample correlation coefficient is produced which determines the strength and the direction of the relationship between the variables (Bhandari, 2021).

The output, r value, serves as the indicator of the strength and direction of the relationship between the involved variables. A positive value signifies a positive direction while a negative one implies the opposite. Moreover, the strength of the association is categorized based on the general rule of thumb where >.05 is strong, between 0.3 and 0.5 implies moderate, and less than 0.3 is weak (Tuney, 2024).

Hypothesis 9: ***Awareness of negative consequences has a significant and positive influence on cross-border online shopping behaviour.***

As shown in Table 10, awareness of negative consequences (ANC) and behaviour (BHVR) towards cross-border online shopping behaviour has a moderate positive and statistically significant relationship. Therefore, the hypothesis is valid.

This suggests that an increase in the awareness of negative consequences among online shoppers would lead to an increased behaviour towards cross-border online shopping.

Table 10: Summary of the result to check significant and positive influence of ANC on BHVR

Hypothesis	ANC	BHVR	Result
ANC	1		Significant and (Moderate) Positively Correlated
BHVR	.375**	1	

*Note. **. Correlation is significant at the 0.01 level (2-tailed); (Source: Author)*

Hypothesis 10: ***Environmentally conscious behaviour has a significant and positive influence on cross-border online shopping behaviour.***

As shown in Table 11, the relationship between environmentally conscious behaviour (ECB) and behaviour towards cross-border online shopping (BHVR) is statistically significant and strongly positively correlated. Therefore, the hypothesis is valid.

This suggests that an increase in an environmentally conscious behaviour among online shoppers would lead to an increased behaviour towards cross-border online shopping.

Table 11: Summary of the result to check significant and positive influence of ECB on BHVR

Hypothesis	ECB	BHVR	Result
ECB	1		Significant and Strongly Positively Correlated
BHVR	.662**	1	

*Note. **. Correlation is significant at the 0.01 level (2-tailed); (Source: Author)*

4. FINDINGS AND DISCUSSIONS

4.1 High Level of Carbon Footprint Awareness

High level of awareness about carbon footprint is observed from the respondents living in New Zealand. The high score suggests that the respondents have a decent understanding of the notion of carbon footprint and its negative effects on the environment. The respondents acknowledge that an increase in carbon footprint is a result of various economic and human activities, evident from the survey question that earned the highest individual mean score. The results also suggest that the respondents are conscious of the environmental implications brought upon by carbon footprints and recognize that it affects climate change. High awareness level about carbon footprint in New Zealand is a sign that public awareness campaigns concerning the topic has good visibility and audience reach.

Although all awareness-related questions earned high scores, it is noteworthy to recognize that items relating to the use of digital devices garnered the lowest scores. This implies that respondents may not be well-informed about the carbon footprint implications caused by the usage of electronic devices and the Internet, despite its cruciality in making online purchases. Use of technology requires electricity consumption, thus, digital devices, including the Internet, drive surge in energy consumption which affect the overall Carbon Dioxide emissions (Karabatak & Alanoğlu, 2022). Technology-driven emissions can be considered as a sub-topic of carbon footprints known as *digital footprints*. Digital Carbon Footprints are "the CO2 emissions resulting from the production, use and data transfer of digital devices and infrastructure" (Evangelidis & Davies, 2021). These are emissions from the usage of digital and other electronic devices. With digitalization on the rise, knowing the impact of online shopping activities towards carbon footprint can be given focus in terms of disseminating awareness messages.

4.1.1 No Significant Difference in Carbon Footprint Awareness according to gender

There is no significant difference in terms of carbon footprint awareness according to gender. This coincides with findings from a previous study where significant difference in carbon footprint awareness is also found inexistent between male and female groups among postgraduate students (Dash et al., 2023).

Although there is no significant difference based on the result of the study, in relation to environmentalism, more positive environmental attitudes are observed from female due to social role differences, mainly due to the notion that females tend to be the caregiver of the society, entailing a more positive stature than others. Also, there are numerous studies implying that females are more involved in pro-environmental activities (Hansmann et al., 2020; Silvi & Padilla, 2021). Such pro-environmental aspect can be considered aligned with the findings of the study as females displays a higher level of awareness than males. Due to the difference in social roles in this modern era, there can be differences, although insignificant, in the awareness levels based on gender. The findings also signify that in raising awareness or disseminating information, similar strategies may be applied for both female and male, in the context of carbon footprint awareness. However, for general sustainability, communication techniques may still be modified to have a more effective approach and reach as other studies exhibit opposing findings regarding differences in gender (Zhao et al., 2021).

4.1.2 Significant Difference in Carbon Footprint Awareness according to age

Significant difference in the level of carbon footprint awareness between age groups is observed. This is exhibited between the age groups of the young adults

(26 to 35 years old) and middle-aged adults (36 to 45 years old). While the carbon footprint awareness level significantly varies between these two groups, the rest of the age groups do not have a significant difference upon comparison. The younger adult group exhibits higher level of awareness than the middle-aged adult group which is opposed to the linear ascending and inverse U-shape trends as highlighted by previous studies (Morrison & Beer, 2017; Surmelioglu & Seferoglu, 2019).

With the significant difference present in age groups, differences in perception and actions may be expected. In terms of disseminating awareness across the public, disparity in age groups may be considered to improve effectivity of communication.

4.1.3 No Significant Difference in Carbon Footprint Awareness according to education

There is no significant difference in the level of carbon footprint awareness according to education level. However, taking into consideration the individual findings from different studies which focused on studying specific education groups, varying level of awareness is observed (Dash et al., 2023; Öz-Aydin, 2016). This implies that, although educational qualification does not entail a significant difference in the level of awareness among online shoppers, there are other crucial factors in the education aspect and sector that are needed to be focused on. For example, incorporating sustainability-related topics into the programs' curriculum or the quality of the content of the educational materials might entail more impact on the carbon footprint awareness among online shoppers rather than their education level. This is observed from the findings of a previous study where there were varying levels of significant differences observed among students belonging to different streams of education programs (Dash et al., 2023).

4.1.4 Significant Difference in Carbon Footprint Awareness according to income level

A significant difference exists in carbon footprint awareness levels among different income level groups. Specifically, the awareness level of the no income group varies significantly with those 5,000 to 75,000 earners. The former has lower level of awareness compared with the latter. Furthermore, the no income group earned the lowest mean score among all income groups. However, the mean score among the groups does not exhibit a linear uptrend. Therefore, awareness level does not rise with income level.

Considering the significance in the difference among the income level groups, it may imply that financial status may be a factor in the promotion of awareness.

However, other aspects of financial background may affect carbon footprint awareness such as financial literacy, education level, and lifestyle choices.

4.1.5 No Significant Difference in Carbon Footprint Awareness according to online shopping frequency

Significant difference in carbon footprint awareness level according to the frequency of overseas online shopping was not observed. Also, there was no pattern in the mean score that supports a correlation in terms of carbon footprint awareness and the frequency in online shopping. This implies that regardless of how often an individual participates in online shopping, the awareness level about carbon footprint does not significantly vary. Generally, in terms of dissemination of information to promote carbon footprint awareness, online shopping frequency may be or may not be considered based on the result.

4.1.6 Awareness about Carbon Footprint significantly influences attitude towards cross-border online shopping

Result showed that carbon footprint awareness affects the attitude of the shoppers towards cross-border online purchasing. Similar with other studies in the pro-environment context, awareness influences and exhibits a strong relationship with attitude (Aminrad et al., 2013; J. Zhang et al., 2022). This implies that shoppers who have increased awareness about the concept of carbon footprints tend to have stronger attitude towards cross-border online shopping as a contributor of carbon emissions. A change in perception towards cross-border online shopping is plausible if awareness is raised.

Public perception towards online shopping can be swayed through awareness and informative campaigns. Awareness about carbon footprint can shape an individual's attitude towards the environmental implications of overseas online shopping. This also implies that it is important to disseminate the right kind of information in spreading awareness about carbon footprints considering that it greatly impacts one's beliefs towards the concept.

Respondents demonstrated a high level score in the attitude section. This is an indicator that the current perception level of New Zealanders towards overseas online shopping as a carbon footprint contributor is high and this coincides with the high awareness level displayed by the respondents. The high level of awareness and attitude on carbon footprint exhibited based on the survey can be attributed to the increased exposure and coverage about the climate change crisis in New Zealand due to the impact of recent natural disasters such as cyclones and flooding.

4.1.7 Attitude significantly influences cross-border online shopping behaviour

Online shoppers' attitude towards carbon footprint has a significant impact on their online shopping behaviour. If an individual thinks that cross-border online shopping brings an increase in carbon emissions, then it is likely that purchasing behaviour is also affected. Moreover, attitude can be seen as a catalyst in changing one's behaviour as seen in other published studies (Olson & Stone, 2005; Sharda, 2019). However, some studies also highlighted concerns regarding the attitude-behaviour gap in environmental sustainability. The attitude-behaviour gap refers to the phenomena where the positive intention or motivation do not materialize into the expected purchasing behaviour (Morwitz et al., 2007). This remains as a topic of interest in the current landscape of sustainable consumption. In this case, the gap is not explicitly exhibited based on the research findings.

Shoppers perceive online shopping as an activity that brings greater carbon emissions hence resulting to larger carbon footprint. Preference to buy from domestic online shops rather than overseas ones are more prevalent. These points are supported by the high level score under the Attitude category gathered from the study.

With the observed significant influence of attitude on behaviour, a change in attitude also translates to a change in the purchasing behaviour. If shoppers exhibit strong attitude towards carbon footprint reduction, then there is a high chance that green purchasing behaviour or inclination to buy in a more eco-friendly manner follows such that participation on cross-border online shopping activities is halted or reduced. Moreover, preference on patronizing domestic online shops than international ones can also be expected. However, as the scope of the study is limited to the key aspects involved in the KAB framework, other social and situational factors may be explored for further investigation to have a deeper understanding of the attitude and behaviour dynamics.

4.1.8 Awareness about carbon footprint significantly influences cross-border online shopping behaviour

Based on the findings, carbon footprint awareness level has a significant influence on an individual's overseas online purchasing behaviour, implying that any change with the former may also impact the latter. This is similar with a finding that carbon footprint awareness has a significant relationship with employment of carbon footprint practices (Cogut et al., 2019; Dash et al., 2023). However, there are disagreements surrounding this topic in sustainability as there are beliefs that awareness does not equate to a significant change in behaviour (Balsas, 2006).

Based on the mean score achieved by each variable, awareness scored high while behaviour earned a moderate level. This depicts differences if the two dimensions

are compared. This implies that despite having a high level of carbon footprint awareness, shoppers do not fully apply the concept into their actual practices. This is not an unusual phenomenon considering that there are gaps present in previous findings when it comes to awareness-knowledge-behaviour levels, in the concept of sustainability (Antimova et al., 2012). However, this entails an opportunity considering the presence of a significant influence, changes in the awareness level implies that a behavioural change may also occur.

Increasing the carbon footprint awareness of shoppers can affect their purchasing behaviour such that they are likely to be more conscious of the amount of carbon emissions before making the actual purchase. Considering awareness level is high, online shoppers tend to opt for international online purchases when transportation modes and packaging materials are considered eco-friendly and emit low carbon emissions. Implications resulting from carbon footprints are also considered hindrances from buying from overseas online vendors. Furthermore, with high awareness, there's a preference on buying from domestic shops rather than the overseas online ones due to the consequences caused by carbon footprint.

4.1.9 Awareness of negative consequences has a significant and positive influence on cross-border online shopping behaviour

Awareness of negative consequences positively influences cross-border online purchasing behaviour. This implies that an increase in the awareness of shoppers about the negative effects of cross-border online shopping to the environment also entails an increase in the behavioural aspect of the consumers such that they take into consideration the carbon footprint impact of their purchases and are likely to consider domestic online shopping instead. The findings of the study can be considered aligned with a study that confirms that the awareness of negative consequences of cross-border E-commerce results to a lesser amount or volume of cross-border purchases (Schleiden & Neiberger, 2020).

The positive correlation signifies that as shoppers get more aware about the negative effects of the freight traffic such as pollution and other environmental repercussions, the higher the chance that consumers consider the carbon footprint impact of their overseas purchases and the more inclination they can have towards domestic online shopping instead for lesser carbon emissions. If the consciousness about the involved energy consumption in the end-to-end transportation cycle and the presence of the amount of carbon emission in the atmosphere for cross-border E-commerce increases, then the shoppers are likely to behave in a manner where carbon footprint implications are considered in the aspect of transportation and packaging materials.

Based on the study, New Zealanders have high awareness of negative consequences of cross-border online shopping as the mean score earned for this factor is high. This means that New Zealanders are well-informed about the implications of online shopping from overseas shops. Therefore, if the current high level of awareness pertaining to the consequences of carbon footprint onto the environment among online shoppers further increases then the behaviour to practice online purchasing with less carbon emission is also bound to increase. This also signifies an opportunity such that this sustainability-related factor can be tapped if a boost in domestic online shopping behavior is intended.

4.1.10 Environmentally conscious behaviour has a significant and positive influence on cross-border online shopping behaviour

This demonstrates that an increase in the eco-friendly behaviour of shoppers entails an increase in their purchasing behaviour where carbon footprint consequences are considered before making the purchase. This coincides with a study that shows that environmentally conscious behaviour results to a lesser volume of purchases involving cross-border online shopping (Schleiden & Neiberger, 2020).

As individuals display more consciousness towards the environment, domestic online shopping is preferred as it is believed to emit lesser carbon emissions. If a shopper inherits an increased consciousness towards patronizing eco-friendly products, participating in initiatives that promote saving of the environment and eco-friendly practices, then an increase in participating in online purchasing with less carbon footprint aftermath can be expected. With the increase in preference towards incorporating environment-friendly practices in one's lifestyle, less online purchases with high carbon footprint effects are observed from the consumers.

New Zealanders display a high level of environmentally conscious behaviour based on the findings. However, it is noteworthy to consider only a medium level score is observed in the purchasing and consuming of eco-friendly goods. This may imply that other factors are taken into consideration in this aspect such as price and accessibility.

4.2 Managerial Implications

The study's findings serve as good baseline of information for the academe and experts in various fields such as communications, marketing, E-commerce, supply chain, and sustainability governance. Key insights may be used as guidelines in developing action plans and strategy in the field of communications or sustainability governance as the influence of behavioural change aspects were also examined. The study confirms the relevance and validity of the theoretical framework behind plausible changes in behaviour, resulting from adjustments of

other dimensions such as awareness and attitude. Findings on socio-demographic factors may also serve as reference for a targeted reach. Communication and segmentation techniques may be applied to further enhance the effectiveness of audience reach in increasing awareness.

Moreover, the study showed the relationship between sustainability-related factors and purchasing behaviour which may help expand the overall landscape of marketing, sustainability, and corporate social responsibility in influencing consumers and other relevant stakeholders.

The supply chain sector and experts in the E-commerce industry may also benefit from the study's findings as packaging and transportation methods were highlighted in the survey. Incorporating sustainability aspects into different components of the supply chain can significantly influence the purchasing behaviour of consumers. These may involve using eco-friendly packaging materials and transportation or delivery methods that involve lesser carbon emissions.

5. RECOMMENDATIONS AND FUTURE RESEARCH

The study's main objective is to serve as a foundation of knowledge about carbon footprints and its relevance to cross-border online shopping hence the focus was primarily around the subject of awareness level. Considering that there is a wide array of constructs involving behaviour, it is recommended that future studies explore other theories or frameworks that further examine behavioural aspects to bridge the relationships between carbon footprint and cross-border E-commerce. Relevant to the commercial side of E-commerce, other factors such as price, convenience, accessibility can be further explored to determine the strength of influence towards consumer behaviour. Moreover, it is recommended to employ a hybrid or qualitative research to further explore the cruciality and influence of other factors that affect a change in the awareness level or behaviour of the consumers to get a deeper understanding of sentiments and perception.

Furthermore, due to the limited availability of studies in New Zealand, it is recommended to embark on further studies related to carbon footprint and E-commerce to expand the knowledge landscape. Especially with the current growing trends in these spaces in the country and the spotlight that these topics have earned recently due to the natural disasters attributed to climate change, it is imperative to have a greater understanding on these subject areas.

5.1 Research Limitations

The study was focused on utilizing a quantitative approach in exploring findings and insights due to the limited timeline of completion for the researcher. This restricted the employment of a hybrid approach to further explore a qualitative

approach to uncover deeper insights and perceptions from the respondents. By using a qualitative approach through open-ended questions, respondents can elaborate their points, providing clearer perspectives to the researcher.

In terms of the research sampling used in this research study, most of the respondents were from Auckland, New Zealand. As the study is supposed to represent general responses from New Zealand residents, a heavy saturation of respondents coming from Auckland may entail a potential bias. Auckland City is the most populated city in New Zealand and has approximately 1.4 million in population, comprising around 27% of the whole country's population (O'Neill, 2024). In this context, the majority of getting respondents from Auckland City can be considered as a good representation of New Zealand. However, for future studies, samples from different locations in New Zealand is deemed as a better fit in representing the population of the country.

6. CONCLUSIONS

Sustainability remains one of the most pressing global concerns, particularly in the context of accelerating globalization and digital transformation. Carbon footprint reduction has become a central focus of environmental policy and academic inquiry due to its direct relationship with climate change (Wiedmann & Minx, 2008; Selin, 2024). As E-commerce continues to expand, especially across borders, concerns regarding the environmental consequences of online consumption have intensified. Prior studies suggest that cross-border E-commerce typically involves higher energy use and carbon emissions due to extended transportation distances and complex logistics networks (Jeroschewsk, 2015; Schleiden & Neiberger, 2020). Against this backdrop, this study contributes to the growing literature by examining carbon footprint awareness and its behavioural implications in the context of cross-border online shopping in New Zealand.

The findings demonstrate that New Zealand consumers exhibit a generally high level of carbon footprint awareness, reinforcing earlier research that identifies awareness as a critical precursor to sustainable consumption behaviour (Cogut et al., 2019; Dash et al., 2023). However, this study extends existing knowledge by showing that awareness alone does not translate uniformly across demographic groups. Significant differences were observed based on age and income level, while gender, education level, and frequency of online shopping did not produce statistically significant variation. These results partially contradict prior studies that suggest education level as a strong predictor of environmental awareness

(Öz-Aydin, 2016; Dash et al., 2023), indicating that contextual and socio-economic factors may play a more prominent role among online shoppers in New Zealand.

A key contribution of this study lies in empirically validating the Knowledge–Attitude–Behaviour (KAB) framework within the specific context of cross-border E-commerce. Consistent with earlier environmental behaviour research (Aaker & Day, 1974; Aminrad et al., 2013; Zhang et al., 2022), carbon footprint awareness was found to significantly influence consumer attitudes toward cross-border online shopping, which in turn significantly affected purchasing behaviour. Importantly, the study also found a direct relationship between awareness and behaviour, suggesting that awareness-raising initiatives may exert both indirect and direct effects on sustainable consumption decisions. This finding contributes to ongoing debates surrounding the awareness–behaviour gap (Antimova et al., 2012; Morwitz et al., 2007) by demonstrating that, while the gap persists to some degree, awareness can still act as a meaningful lever for behavioural change in online retail contexts.

Beyond the core KAB relationships, the study advances the literature by incorporating sustainability-related constructs—specifically awareness of negative consequences and environmentally conscious behaviour—into the analysis of cross-border online shopping. The positive and significant influence of these factors on purchasing behaviour aligns with and reinforces prior findings in cross-border E-commerce sustainability research (Schleiden & Neiberger, 2020). This study confirms that consumers who are more conscious of environmental consequences and who already engage in eco-friendly behaviours are more likely to adjust their online shopping practices to reduce carbon footprint impacts, including favouring domestic online retailers.

In the New Zealand context, these findings are particularly relevant given the country's strong national commitment to sustainability and climate action. By identifying the behavioural mechanisms through which carbon footprint awareness influences online purchasing decisions, this study provides evidence-based insights that can inform public communication strategies, sustainability education, and E-commerce policy development. The results suggest that targeted awareness campaigns—especially those emphasizing the negative environmental consequences of cross-border logistics—can play a crucial role in encouraging more sustainable online consumption patterns.

Despite these contributions, the study has limitations that warrant consideration. The reliance on a quantitative approach restricts deeper exploration of consumer motivations and decision-making processes, while the concentration of respondents in Auckland may limit geographic representativeness. These limitations highlight opportunities for future research to adopt mixed or qualitative methods and to explore additional contextual factors such as price sensitivity, convenience, and trust in sustainability claims. Further comparative studies across countries would also enhance understanding of how cultural and infrastructural differences shape the relationship between carbon footprint awareness and cross-border E-commerce behaviour.

Overall, this study contributes to the sustainability and E-commerce literature by empirically demonstrating how carbon footprint awareness, attitudes, and sustainability-related behaviours interact to influence cross-border online shopping decisions. By situating its findings within established theoretical and empirical work, the study confirms, extends, and in some cases challenges prior research, offering a nuanced understanding of sustainable online consumption in a rapidly globalizing digital economy.

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Leveraging Informatics to Enhance Customer Experience in New Zealand Retail Businesses

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ABSTRACT

The modern retail market in New Zealand increasingly relies on customer experience as a key source of competitive advantage amid rapid digital transformation. This study examines how retail businesses leverage informatics technologies, including Customer Relationship Management (CRM) systems, artificial intelligence (AI), and data analytics platforms, to enhance customer experience. Drawing on the Technology Acceptance Model (TAM) and Service-Dominant Logic (SDL), the research investigates the relationships among technology adoption, service innovation, and value co-creation in retail settings. A mixed-methods approach was employed, combining survey data from retail managers with qualitative insights from frontline service personnel. The findings indicate that effective implementation of informatics technologies improves personalized service delivery, operational efficiency, and overall customer satisfaction. However, successful outcomes depend significantly on organizational readiness and employees' perceived usefulness and ease of use of these systems. Small and medium-sized retailers face challenges in translating technological investment into meaningful customer engagement improvements. By focusing on the under-researched New Zealand retail context, this study contributes to digital retail transformation literature and provides practical guidance for managers seeking to align informatics capabilities with customer-centric business strategies to strengthen competitiveness.

Keywords: *Customer Experience; Retail; CRM; Artificial Intelligence; TAM; SDL; New Zealand*

1. INTRODUCTION

The digital economy has transformed retail competition because businesses now need to deliver exceptional customer experiences to succeed instead of relying solely on price or product selection. This shift toward experience-based competition has been widely documented in prior studies on digital

transformation and service innovation (Vargo & Lusch, 2004; Vargo & Lusch, 2008; Flavián et al., 2023). Digital technology transforms consumer actions so retailers must create retail experiences which offer customized service through improved operational links between different communication platforms. Studies show that digital technologies increase customer expectations for convenience, personalisation, and seamless interactions across channels (Venkatesh et al., 2003; Zhang & Venkatesh, 2019). Businesses need to build customer relationships through perception-based interactions because the market shift toward experience-based value development will determine their success (Vargo & Lusch, 2004; Vargo & Lusch, 2008).

The retail sector in New Zealand must adapt to major changes because it generates economic expansion which establishes employment opportunities that benefit communities throughout the country. The retail industry operates within a specific market area which includes numerous small and medium-sized businesses (SMEs) that face strong competition from one another. For example, many New Zealand SMEs operate in highly localised markets while competing with national and international online retailers, increasing pressure to differentiate through customer experience rather than price alone (Retail NZ, 2023; MBIE, 2022). The digitally connected New Zealand consumer base demands value for money while seeking experiential experiences which forces retailers to maintain uniform customer experiences between their brick-and-mortar stores and online platforms (Retail NZ, 2023). Examples include the adoption of integrated loyalty programmes, online customer support, and data-enabled customer engagement tools by New Zealand retailers to ensure consistent service across channels (Nguyen & Simkin, 2022). Retailers have established customer experience as their main strategic focus because it creates lasting market leadership. Prior research links superior customer experience capabilities to sustained competitive advantage and long-term firm performance (Barney, 1991; Kotler et al., 2021).

The retail industry now uses CRM systems and Artificial Intelligence (AI) and data analytics technologies to completely transform its customer data management operations. Empirical evidence supports the effectiveness of CRM, AI, and data analytics in retail settings. Industry and academic studies report that organisations adopting analytics-driven CRM and AI technologies experience measurable improvements in customer satisfaction, loyalty, and operational performance, particularly through enhanced personalisation and faster service delivery (Davenport & Harris, 2017; IBM, 2020; Kotler et al., 2021). Furthermore, research indicates that data-enabled retailers are better positioned to anticipate customer needs and sustain long-term customer relationships compared to less digitally mature competitors (Smith & Zhang, 2021; Huang & Rust, 2018). Organisations can process extensive data from customer interactions

and loyalty programs and e-commerce systems and store operations through these technological solutions. The implementation of informatics tools leads to better customer satisfaction and loyalty because these systems enable businesses to create individualized marketing campaigns and predict customer needs and offer quick service solutions (Davenport & Harris, 2017; Huang & Rust, 2018; Marulli et al., 2020).

Research conducted across various nations shows that retail organizations which base their choices on data will obtain superior customer retention and enhanced business stability (Kotler et al., 2021; Smith & Zhang, 2021). The deployment of informatics technology for customer experience management leads to varying results because small and medium enterprises (SMEs) encounter difficulties when attempting to utilize this technology. This inconsistency can be explained by differences in organisational readiness and technology acceptance within SMEs. Prior research indicates that successful utilisation of informatics technologies depends not only on technology investment, but also on employees' digital competencies, perceived usefulness of systems, and willingness to adopt new technologies in daily work practices (Davis, 1989; Venkatesh & Davis, 2000; Gex et al., 2011). As a result, technology adoption without sufficient skills development and change management may fail to translate into improved customer experience outcomes. Retailers who use digital technologies do not achieve improved customer experience outcomes from their technology spending.

Research about informatics and customer experience in academic settings mainly studies big digital markets but fails to provide useful information about New Zealand as a small economy. For example, prior studies have predominantly examined informatics-enabled service ecosystems and customer experience in large organisations and developed or international markets, where higher levels of digital maturity and resource availability differ significantly from those of small economies (Akaka et al., 2013; Chandler & Lusch, 2015; Storbacka et al., 2016). The existing research studies technology adoption and customer experience independently from each other while lacking sufficient theoretical frameworks which explain how customers accept new technology and generate value from it. The TAM shows that users will adopt technology based on their assessment of system worth and their interactions with system interfaces (Davis, 1989; Venkatesh & Davis, 2000). SDL shows that organizations and their customers create value together by working together in their mutual interactions (Vargo & Lusch, 2004; Lusch & Nambisan, 2015). However, while TAM explains technology acceptance and SDL explains value co-creation, existing studies rarely integrate these two perspectives to examine how technology acceptance enables value creation through informatics-enabled customer

experience. However, their combined application to informatics-enabled customer experience in the New Zealand retail sector remains underexplored.

This article addresses this gap by investigating how informatics technologies are adopted and utilised to enhance customer experience in New Zealand retail businesses through an integrated TAM, SDL perspective (Davis, 1989; Venkatesh & Davis, 2000; Vargo & Lusch, 2004; Lusch & Nambisan, 2015). The research investigates how informatics technology supports customized service delivery and operational improvements and value creation while determining which business elements and external conditions affect technology deployment success (Akaka et al., 2013; Chandler & Lusch, 2015; Zhang & Venkatesh, 2019). The research provides specific findings about the New Zealand retail industry which enhance the existing knowledge about digital retail evolution and customer experience management (Nguyen & Simkin, 2022; Flavian et al., 2023).

2. THEORETICAL FRAMEWORK

2.1 Conceptual Framework: Informatics, Technology Adoption, and Value Co-Creation

The research unites TAM and SDL through an integrated conceptual framework which shows how informatics technologies improve retail customer experiences. The two frameworks operate independently to provide distinct views about customer adoption of new technology and their experience of value during its development process.

Figure 1: An integrated conceptual framework illustrating how informatics technologies influence customer experience in retail through technology acceptance (TAM) and value co-creation mechanisms (SDL)

(Source: Author)

The research unites TAM and SDL through an integrated conceptual framework which shows how informatics technologies improve retail customer experiences. The TAM model explains technology adoption through two essential factors which include user perceptions of system value and system operation simplicity. The successful deployment of informatics tools which include CRM platforms and AI-driven analytics and automation systems by retail managers and frontline staff needs three essential elements. The perception of usefulness in technology directly relates to specific results which organizations can measure through better customer separation and quicker service operations and superior decisional capabilities. The extent to which retail staff can use technology at work without encountering major obstacles determines their assessment of system ease of use.

The research combines TAM and SDL to develop a two-stage model which explains how people adopt informatics systems. First, technologies must be accepted and used by organisations and employees (TAM). Organizations need to use these technologies as strategic tools which enable value creation through customer involvement according to SDL. The integrated framework delivers its most significant value to New Zealand retail operations through its combination of relational service with trust and community engagement to build customer experiences.

2.2 Informatics and Customer Experience in Retail

Research about modern retail focuses on customer experience as its main subject because digital change has occurred. Research now shows that value exists beyond product transactions because it develops through customer interactions which create emotional responses and perception changes during their entire journey. The retail customer experience includes all customer interactions which take place before and during and after the purchase process through physical stores and digital interfaces (Kotler et al.,2021).

Organizations can develop Experience led retail strategies through their adoption of informatics technologies. Retailers use CRM systems and data analytics platforms and AI-driven applications to collect and merge customer information which they obtain from various sales channels. The systems help organizations provide individualized communication and predictive analytics and quick service responses which result in enhanced customer satisfaction and loyalty (Davenport & Harris, 2017; Marulli et al.,2020). Research findings show that organizations which use data to make decisions achieve superior customer retention and customer lifetime value because they create products which match personal customer preferences (Smith & Zhang, 2021).

Retail informatics systems now use AI technology more frequently which enables customer experience management to achieve better operational performance. Retailers can predict customer requirements through AI-based recommendation systems and chatbots and forecasting platforms which provide immediate service assistance to customers. The research by Huang and Rust (2018) shows AI enhances service delivery through its data analysis capabilities and situation-based adaptation which enables large-scale retail environments to provide individualized services. Organizations need to possess both sophisticated technology capabilities and operational power and strategic planning abilities to achieve success with AI implementation.

The research shows that informatics investments do not automatically result in better customer experience because multiple obstacles continue to exist. SMEs face three primary digital adoption challenges because they do not have enough digital skills and they cannot access enough resources and their systems fail to integrate properly (Gex et al.,2011; KPMG New Zealand, 2019). The problems create difficulties for New Zealand's small economy because its retail sector functions with restricted resources and outdated technology systems.

2.3 Technology Acceptance Model (TAM) and Informatics Adoption

The TAM framework serves as a basic model which explains how organizations choose and implement their information systems. The TAM which Davis (1989) created states that people will adopt technology based on their belief that it is useful and easy to use. The way employees and their supervisors at retail stores perceive these systems determines their readiness to implement informatics tools for their daily operational tasks.

The research community has expanded TAM through multiple studies which prove its ongoing usefulness for organisational research. Venkatesh and Davis (2000) show that users determine system usefulness through the combination of social influence with their cognitive instrumental processes. Venkatesh et al. (The research of Venkatesh et al. (2003) extends the Unified Theory of Acceptance and Use of Technology to include organizational elements and environmental variables. Research findings show that TAM continues to predict technology adoption patterns in retail and SME sectors through digital literacy training and leadership assistance (Zhang & Venkatesh, 2019).

The New Zealand retail sector requires TAM analysis because its retailers show different levels of digital competence. SMEs face difficulties when implementing sophisticated informatics systems because they do not possess the necessary resources which big retail companies already control. Users struggle to use the system because they find it complicated even though they understand its worth during the adoption process. The system produces failed customer experience enhancements through its operations even though organizations spend substantial amounts on informatics projects.

The model TAM helps researchers understand customer adoption patterns but it does not explain how technology creates experiential value for users. The current limitation of TAM requires additional service-oriented analysis which focuses on customer interactions and value creation processes.

2.4 Service-Dominant Logic (SDL) and Value Co-Creation

SDL provides an additional theoretical framework which explains how informatics systems enhance customer experience. The SDL framework opposes conventional goods-dominant perspectives about value because it demonstrates that value emerges from the collective work between businesses and their customers instead of being contained within physical products (Vargo & Lusch, 2004). The customer plays an active role in creating value through service exchange which serves as the fundamental economic process.

SDL continues to grow in value because digital and service-based businesses with retail operations need this method. The customer journey benefits from operant resources which are informatics technologies that enable customers to interact and dialogue and experience personalized interactions. Retailers use CRM platforms and analytics systems to keep customer interactions active because these systems enable them to instantly respond to customer feedback and behavioural data and preference information (Lusch & Nambisan, 2015). The system allows organizations to develop experiential value through interactive processes which replace traditional individual transaction processing.

Empirical research supports the applicability of SDL in retail contexts. Research indicates that customer participation during service interactions results in higher satisfaction levels which produces loyal customers who maintain their loyalty to the company for longer durations (Akaka et al.,2013; Storbacka et al.,2016). The infrastructure which enables large-scale value co-creation in digitally enabled retail spaces operates through informatics systems which unite customer data with service management and business management systems.

2.5 Integrating TAM and SDL: A Conceptual Framework

The adoption process of informatics technologies depends on TAM but SDL shows how these technologies create value by interacting with customers. The combination of TAM and SDL creates an expanded system which enables better analysis of retail customer experience through informatics technology.

The adoption of technology serves as a required yet alone insufficient factor which enables organizations to improve their customer experience. Informatics systems must first be accepted and effectively used by employees and managers, as explained by TAM. Organizations must establish strategic systems according to SDL because these systems will enable them to deliver

customer interactions and create value for their customers. Organizations can achieve maximum return from their informatics investments through the second stage because it verifies that their technology spending aligns with their customer experience goals.

The integrated framework provides an effective method to study how New Zealand retail businesses adopt informatics technology because their organisations show different levels of readiness and service-focused approaches. The framework shows organizations need to link their informatics capabilities with customer-oriented business strategies through its service-based and adoption-based framework.

2.6 Regulatory and Contextual Considerations in New Zealand

The current regulatory and policy frameworks which guide retail operations determine how informatics will be implemented in these operations. The New Zealand government dedicates its digital transformation work to ethical data usage and trust development and skill development for small and medium enterprises (MBIE, 2022). The organization follows these priorities because they support SDL's focus on building trust relationships which informatics enables as a strategic business tool instead of being a simple technical solution.

The Retail NZ (2023) reports that New Zealand retailers understand digital technologies hold value but their small business operations stop them from getting the digital skills they need. The solution of these gaps needs both financial support for technology development and internal learning processes and employee skill improvement and organizational strategy unification.

Research studies show that retail companies experience major changes through informatics technologies which result in enhanced customer experiences. The TAM model helps organizations understand what causes people to adopt new technologies while SDL shows how informatics systems create value by enabling people to interact with each other. The three frameworks establish a complete theoretical framework which enables researchers to study how informatics enhances customer experiences in New Zealand retail businesses while solving implementation problems and developing superior customer experiences.

3. RESEARCH METHODOLOGY

This study adopts a descriptive research design to examine how New Zealand

retailers implement AI, CRM, and data analytics to enhance customer experience and business performance. A quantitative approach is employed to ensure empirical rigor and generalisability. Data are collected through structured questionnaires distributed to retail managers, employees, and customers, focusing on technology adoption, perceived usefulness, service quality, personalisation, and customer satisfaction. The study is grounded in established theoretical frameworks, including the Technology Acceptance Model (TAM) and UTAUT.

A sample size of 385 respondents is determined using a sample size calculator with a 95% confidence level and a 5% margin of error. Survey data are analysed using statistical techniques such as descriptive statistics, correlation, and regression analysis to identify patterns and relationships between technology use and business outcomes.

Primary data collection includes surveys targeting both organisational stakeholders and customers. Manager and employee surveys focus on the adoption of informatics technologies and implementation challenges, while customer surveys evaluate user experience, satisfaction, and interactions with AI-driven services.

Ethical considerations are strictly observed. Participation is voluntary, and informed consent is obtained from all participants. Data are anonymised and handled in compliance with the New Zealand Privacy Act 2020. Ethical approval is obtained through the relevant institutional review process.

Overall, the methodology integrates theoretical and empirical approaches to provide insights into how digital technologies can be effectively leveraged to improve customer experience and operational efficiency in the New Zealand retail sector.

4. ANALYSIS AND FINDINGS

4.1 Informatics-Enabled Personalisation as a Mechanism of Customer Experience Differentiation

The modern retail industry depends on personalization to achieve its competitive advantage which serves as its primary distinction in digital shopping platforms. The personalization method through informatics operates differently from standard segmentation methods which use demographic information and transaction records because it tracks customer preferences and behaviours and environmental elements throughout their entire interaction process. The industry transition shows that businesses now concentrate on

developing personalized customer experiences instead of implementing uniform service methods (Davenport & Harris, 2017; Kotler et al.,2021).

The infrastructure of this transformation depends on Informatics technologies which include CRM systems and customer data platforms and AI-driven analytics. The systems collect information from various customer interaction points which include loyalty programs and e-commerce sites and mobile apps and physical store visits. Retailers use informatics technology to establish immediate personalized interactions which Huang & Rust (2018) and Smith & Zhang (2021) demonstrate lead to higher customer perceived value and emotional connection.

The New Zealand retail sector provides empirical evidence which demonstrates personalization works as a value co-creation system instead of being a simple marketing technique. The personalized meal planning system of My Food Bag lets customers enter their dietary choices and their lifestyle targets and their family requirements. The product development process now accepts customer feedback which allows teams to make continuous product improvements. The company operates its feedback system as proof that SDL upholds the Vargo & Lusch (2004) and Nguyen & Simkin (2022) principle which demonstrates that value creation occurs through customer interactions with products rather than manufacturing processes.

The online supermarket Supie shows how customers can direct service development through its digital platform by using informatics technology. Users of Supie can create their own grocery lists through the platform which allows them to select products based on their dietary requirements and their choice of sustainable items from local sources. The system enhances recommendation systems through customer interaction data which also helps improve inventory management based on shifting customer purchasing patterns (Retail NZ, 2023). The practices demonstrate how businesses use personalization to make operational decisions which create stronger customer relationships through relational customer experience.

Big-box retailers use identical business methods which they implement on a bigger level. The Warehouse Group has created a single CRM and loyalty system which runs across all its brands to deliver instant personalized experiences through both online and offline platforms. The predictive analytics system enables businesses to create specific promotions which result in better customer retention and higher customer lifetime value according to The Warehouse Group (2023). The research results from this study validate earlier studies which demonstrate that personalized experiences create better customer

satisfaction when organizations use informatics systems to deliver these experiences (Marulli et al.,2020).

The sector has achieved multiple successes but personalization techniques do not exist at the same level throughout all organizations. The survey results in the thesis show that most SMEs use non-adaptive rule-based systems which do not possess learning abilities. Personalization initiatives fail to adjust their methods based on customer behaviour changes which leads to decreased experiential outcomes (Nguyen & Simkin, 2022). The comparison reveals how technology implementation fails to match the standards which customers expect for their experience.

The normative method for creating personalized informatics systems creates problems because it endangers patient privacy of their medical information and makes healthcare decisions less transparent while it damages the trust between doctors and their patients. Research done in New Zealand shows that customers want personalized experiences yet they doubt businesses that do not show their data handling methods because these markets have limited customer bases (Research First, 2023). Personalization effectiveness depends on both advanced technology systems and proper ethical management of data and direct information about how organizations use collected data.

4.2 Technology Adoption, Organisational Capability, and Employee Mediation

Organizations can enhance customer experience through informatics technologies because these systems possess technical capabilities but their success depends on how they implement their systems and how users interact with them. The TAM provides researchers with a complete theoretical framework to study employee and manager informatics system adoption by examining their perceptions of system usefulness and operational simplicity (Davis, 1989; Venkatesh & Davis, 2000). The way customers experience service delivery in retail stores determines how well informatics systems generate valuable customer experiences because these settings need staff to interact with customers face-to-face.

Frontline employees serve as vital connections which enable customers to reach organizational services. The team uses data insights from informatics systems to make decisions which they then use to deliver services through various customer interaction channels. The production of customer experience happens through the combination of technology systems with employee actions rather than through technology alone. Employees will avoid using

informatics tools when they view these systems as complicated or when these systems interfere with their work processes or when these systems do not match their current operational methods. The research findings prevent informatics from delivering better customer experiences because they show that technology spending does not match the actual capabilities of service delivery.

The findings of this study indicate that these challenges are particularly pronounced among small and medium-sized enterprises (SMEs) in the New Zealand retail sector. The survey results show that managers and frontline staff have different views about the same workplace issues. Frontline staff members at work sites doubt the value of informatics systems because they find the systems difficult to use and they do not receive proper training and they encounter operational problems when the system is deployed (Nguyen & Simkin, 2022). The different ways healthcare providers view these systems creates barriers which prevent them from using informatics effectively which results in systems being underused despite their operational readiness.

The persistence of this perception gap can be explained through TAM's emphasis on perceived ease of use. This pattern has been demonstrated in prior studies of technology adoption in SME contexts, which show that perceived ease of use and system usability strongly influence whether informatics systems become embedded in daily work practices. Empirical research applying TAM in SME environments finds that limited training, high workload pressure, and usability complexity significantly reduce effective system use, even when technologies are perceived as strategically valuable (Davis, 1989; Venkatesh & Davis, 2000; Gex et al., 2011). System usability becomes essential because SMEs have restricted training resources and their staff members need to handle big workloads while working in environments with minimal resources. The implementation of systems which create mental processing challenges or break down current operational patterns will reduce employee system interaction regardless of their organizational value. As a result, informatics systems may be adopted in principle but fail to become embedded in everyday service practices.

The evidence from the case shows that these two elements function as a unified system. Several retail organisations reported implementing predictive analytics and recommendation systems with the expectation of improved personalisation and responsiveness. The systems failed to enhance customer satisfaction because staff members doubted the system results and the systems required extended periods to address urgent matters. Staff members used established service protocols which produced unchanging and unpersonalised service experiences. The research findings support TAM theory because users need to

find technology usage simple to use for successful adoption when they have limited digital skills and face high operational requirements (Venkatesh et al.,2003).

The Digital Boost Programme operated by MBIE under the Ministry of Business Innovation and Employment functions as a major policy example which shows how capability development initiatives lead to enhanced technology adoption outcomes. The MBIE (2022) program teaches SMEs to implement CRM systems and digital engagement tools and customer journey mapping techniques which enables them to develop operational competencies and provide customer-oriented services. The program focuses on practical learning methods which relate to real-world situations to solve the two main problems which users find the system difficult to use and not useful. The system demonstrates alignment because it describes particular healthcare organization situations which lead to better customer service through informatics system implementation.

The SDL framework shows that employee engagement functions as an operational resource which organizations must develop to generate value by working together. SDL explains that value creation happens through the combination of various resources which include technological assets and business operations and human abilities (Lusch & Nambisan, 2015). The successful deployment of informatics systems requires staff members who have both technical competencies and the drive to use their knowledge when delivering services which lead to better customer experiences. The co-creation process faces restrictions because employee mediation systems fail to operate effectively even though organizations implement modern technological systems.

Organizations need to determine how their automated employee mediation systems will operate with their existing human-based service delivery systems during deployment. The implementation of AI tools helps organizations decrease their work load while achieving better results and enabling better decision processes yet it creates a risk that automated systems will diminish the human elements which customers value in their experiences. The research results show that staff members want informatics systems which function as additional tools to support human decision-making and build stronger emotional connections with others. Healthcare professionals who see informatics tools as service excellence enhancers establish a work environment which allows staff members to accept these systems because they recognize these tools enhance service quality without restricting their professional freedom.

The implementation of informatics technology in New Zealand retail stores depends on three main factors which include technological capabilities and organizational preparedness and staff members who act as connectors between systems. The TAM model enables organizations to identify which elements affect customer adoption choices while SDL shows that human resources enable organizations to generate value through their customer service delivery. Retailers who dedicate resources to employee development and link their information systems to service operations and use technology to support their work will achieve better customer experience results from their informatics adoption.

4.3 Omnichannel Integration and the Co-Creation of Seamless Customer Journeys

The main function of omnichannel integration enables informatics to create a unified customer experience which spans between physical stores and digital retail platforms (Vargo & Lusch, 2008; Retail NZ, 2023). Customers who interact with different retail channels which include websites and mobile apps and social media and physical stores need their interactions to transition seamlessly between these various contact points. Businesses need to offer customers the same prices and complete product information and maintain excellent service quality throughout all their communication channels. Informatics systems enable channel synchronization through their ability to link customer information with inventory access and service operations which results in a continuous customer journey (Retail NZ, 2023).

The SDL framework enables value co-creation through omnichannel integration because it allows retailers to maintain ongoing dialogue with customers. The informatics system allowed organizations to move beyond treating channels as separate contact points because it supported omnichannel strategies which created a unified service environment that monitored and processed customer interactions in real time. The browsing activities of customers along with their buying choices and feedback and their decision to change channels determine their experience while informatics systems use these signals to generate service adjustments. The repeated cycle of interactions between customers and the company strengthens their relationship value while it creates a unified experience throughout the entire customer journey (Vargo & Lusch, 2008).

The implementation of effective omnichannel integration needs strong informatics systems which can unite different systems and data storage locations. The three systems which include CRM platforms and inventory

management systems and analytics tools need to function together for real-time visibility and immediate response capabilities. The absence of integration between systems leads customers to face various types of obstacles which include different information sets and repeated operational steps and system failures. The system breakdowns which happen create trust problems while they harm customer relationships because informatics should operate as a core system foundation instead of being used as an extra service.

A prominent New Zealand example of informatics-enabled omnichannel integration is Countdown (Woolworths NZ). The retailer uses AI-based demand forecasting systems which analyse transaction data together with weather information and local event schedules to determine the best store inventory distribution. The system allows stores to perform instant stock updates based on shifting customer requirements which produces enhanced product availability and decreased waste (Countdown, 2023). The implemented practices enhance customer experience because they provide customers with easier and more dependable shopping experiences which reduces stockout occurrences and establishes trust between customers and the company. This case illustrates how informatics simultaneously supports experiential value and operational efficiency within an omnichannel framework.

The Warehouse Group operates a single CRM system which includes loyalty functions to maintain ongoing customer contact through its mobile applications and website and its brick-and-mortar stores. The system generates customized promotional content which combines all customer interactions from different communication channels into a single understanding (The Warehouse Group, 2023). The method enables customers to experience the brand as one service provider because it maintains continuous relationships between different touchpoints. The company runs its business through a permanent system which matches SDL's customer relationship development model that requires ongoing customer contact.

The New Zealand retail sector demonstrates two distinct operational approaches between retailers who operate with individual informatics systems and those who maintain their systems independently. Organizations that operate with different systems for their business activities encounter challenges when they attempt to develop connected customer experience journeys. The lack of connection between data streams and different service operations methods creates separate customer experiences which include multiple requests for information and price differences and extended service restoration times. The system failures create problems which damage customer trust and

lead to unsatisfied customers because customers need fast service in their current situation.

Retailers who have merged their information systems into one architecture achieve better service management through their ability to take proactive measures. Businesses can identify service problems early through unified customer data which enables them to start immediate solutions. The analytical data from customer information systems enables retailers to forecast what their customers will need. Organizations build superior customer relationships through their flexibility to understand customer needs and their ability to create individualized communication which leads to enduring customer loyalty. Organizations will achieve superior omnichannel customer experience results through integrated systems which provide more strategic value than systems that operate independently.

Organizations need to establish operational efficiency while providing service accessibility to all customers when they implement omnichannel integration. Retailers who focus on digital channels without proper support for other customer contact methods will drive away part of their customer base. The implementation of informatics technology allows businesses to create omnichannel strategies which maintain human contact and flexible service delivery to build trust relationships with customers who will stay engaged in the long run. This reinforces the view that informatics functions most effectively as an enabler of pluralistic service ecosystems rather than as a mechanism for standardisation alone.

The main route through which informatics supports New Zealand retail to create unified customer experiences exists through omnichannel integration. The integration of customer information with service operations and operational systems through different channels enables informatics to create experiential coherence and maintain relational continuity and enable adaptive engagement. Organizations need their systems to work together seamlessly while they maintain their focus on developing service designs which include all customers. Retailers who understand these connected elements will achieve better results through informatics because they can use it to create strategic customer experiences which build enduring relationships.

4.4 Informatics, Trust, and Ethical Governance in Customer Experience Design

The expansion of informatics systems in retail service operations requires better trust management systems and ethical governance frameworks to achieve improved trust management (Vargo & Lusch, 2016; Storbacka et al., 2016). Digital systems generate customer experiences through their operational efficiency and convenience but also through how customers experience fairness, control, and receive respect during their system interactions (Oliver, 1980; Flavián et al., 2023). The small New Zealand market will face major damage to customer trust and brand credibility because social proximity and reputational effects create strong effects throughout this market (MBIE, 2022; Retail NZ, 2023).

The findings of this study indicate that New Zealand consumers generally recognise the benefits of informatics enabled services, particularly in terms of personalisation and convenience. The acceptance exists under particular circumstances which establish the boundaries of its acceptance. People today show increasing worry about how businesses handle their personal information which they store and use for their operations. Research First (2023) identifies three essential challenges which affect customer participation in digital retail services because these challenges include informed consent requirements and algorithmic decision transparency and data protection. The evaluation of customer experience now depends on ethical assessment because trust stands as the main factor which determines its value.

SDL requires trust as its fundamental element which enables value co-creation between parties. SDL explains that value development happens through ongoing customer firm interactions which enable shared resource utilization (Vargo & Lusch, 2004). Customers will stop participating in activities when trust fails to exist because they will refuse to share their data or leave digital platforms which block the co-creation process. Organizations need to solve information power imbalances which result from their use of informatics technologies with personalization and response systems to protect their relationship-based value.

The research shows that customers make distinctions between data applications which they view as helpful and those which they consider to be exploitative. Service relevance improves through personalization practices which customers accept but they remain sceptical about practices that lack transparency and provide restricted customer control. Healthcare informatics systems need detailed explanations together with particular medical functions because their distinction proves their essential nature. Retailers who show their data usage methods for service improvement will gain customer trust which results in longer customer relationships.

Ethical informatics practices require regulatory frameworks to function properly for their development. The Privacy Act 2020 of New Zealand requires organizations to establish transparent procedures for personal data processing which limits data application to authorized purposes and safeguards customer entitlements. The Ministry of Business Innovation and Employment (MBIE) creates policies which meet public requirements for ethical data practices and support digital development of businesses especially those from small and medium enterprises (MBIE, 2022). The frameworks define essential compliance standards which show which standards users of technology need to follow for responsible technology practice.

The normative perspective requires more than compliance because it does not guarantee successful customer experience results. Retailers need to advance their ethical governance practices by actively protecting customer information and their digital interactions with customers. The process requires ethical principles to become integrated into system development and decision processes and organizational values. Privacy by design principles need to become fundamental service delivery elements of CRM and analytics platforms because customers must have control and consent to use these systems.

The requirement for ethical governance creates challenges because it needs to achieve two goals which are developing equitable algorithms and sustainable system management systems. AI systems which generate recommendations and set prices and determine service order need proper monitoring to prevent them from creating or strengthening existing biases. The results from retail operations will create negative impacts on customer trust because they violate their sense of fairness. Organizations need to create active governance systems which will monitor their informatics systems as these systems evolve through time.

The ethical elements of customer experience through informatics become more complex because Employee mediation plays a role in this process. Frontline staff members function as customer system connectors who explain operational procedures to customers and provide answers about data management practices to customers. The communication of ethical practices by employees to customers becomes less effective because staff members who do not understand informatics systems or feel uncertain about their operation. The organization needs to build its capabilities through two approaches which include developing technical skills and acquiring ethical knowledge.

Organizations can create future customer experience design through strategic value which ethical governance practices generate. The process of rebuilding

trust becomes difficult because negative feedback spreads quickly through social networks in small market areas which have already suffered damage to their trust relationships. Organizations that use ethical leadership in their informatics systems will develop better corporate reputation which produces enduring organizational benefits that extend past individual customer interactions. Ethical governance functions as a risk reduction method which generates special business experiences that result in sustainable market dominance.

The proper operation of New Zealand retail customer experience through informatics depends on trust-based ethical governance systems which need to exist for proper functioning. While digital technologies offer powerful tools for personalisation and efficiency, their effectiveness ultimately depends on customers' willingness to engage and share data. Retailers who connect their informatics strategies to transparency principles and customer control methods and relational value creation will establish trust-based customer relationships which fulfil their ethical responsibilities and enable them to provide enduring customer satisfaction.

The research shows that informatics technology in New Zealand retail stores creates better customer experiences through its ability to personalize services and its successful implementation and its capability to link different sales channels and its commitment to ethical practices and its strategic position in the market. The research findings from real-world cases and empirical evidence in the thesis show that organizations need three core elements to enhance customer experience which include organizational readiness and employee engagement and trust-based data practices. The section unites TAM and SDL with New Zealand research data to develop a complete explanation which demonstrates how informatics systems create sustainable retail market leadership.

5. DISCUSSION AND IMPLICATIONS

The research investigates how informatics technology enables customer experience through its effects on retail sector technology adoption and organizational capabilities and value creation processes. The research combines TAM and SDL findings to create an entire framework which explains how informatics systems generate experiential results. The research results support earlier studies which show that technology deployment does not lead to better customer experiences because organizations need to match their technological resources with their service delivery methods and implementation readiness (Davis, 1989; Vargo & Lusch, 2004; Lusch & Nambisan, 2015).

5.1 Theoretical Implications

The present study adds theoretical value to the field through its proof that TAM and SDL should be studied together to understand how informatics create better customer experiences. The TAM model shows how organizational members accept new technologies through their mental processes and actions but SDL examines how these technologies enable value co-creation through social interactions (Venkatesh & Davis, 2000; Vargo & Lusch, 2008). The research indicates that models which focus on adoption do not fully explain how customers experience technology because technology acceptance does not automatically create customer value until informatics systems become part of service operations which enable customer interactions and maintain relationships.

This paper applies this complete framework to New Zealand retail operations to build upon previous studies which have concentrated on big markets and digital businesses (Huang & Rust, 2018; Smith & Zhang, 2021). The research findings show that organizational barriers along with staff intervention and service delivery standards determine the success of informatics system implementation in restricted economic markets. The research environment needs digital retail studies to study specific market characteristics while showing how informatics systems create value through complete service environment assessment (Akaka et al.,2013; Storbacka et al.,2016).

The research provides new insights to the growing body of knowledge about informatics as an operational resource which operates within service-based systems. The research findings validate SDL because they demonstrate that customer experience value from informatics develops through customer interactions which establish trust-based relationships that drive customers to become active participants (Vargo & Lusch, 2016). The research findings show that organizational elements together with individual worker attributes decide which staff members will use their perceived usefulness and ease of use according to TAM (Venkatesh et al.,2003; Zhang & Venkatesh, 2019).

5.2 Managerial Implications

The findings show retail managers should use informatics as a business solution which creates better customer experiences instead of buying it as a basic technological product. CRM systems and analytics platforms and AI-enabled tools need to link directly with customer experience targets while organizations need to merge these systems with their service design and delivery operations. The research findings from previous studies support this

discovery because analytics and data-based decision systems create strategic value for customers (Davenport & Harris, 2017; Marulli et al.,2020).

The organization needs capable employees to achieve its goals. Managers need to focus on training programs and change management systems and employee participation during informatics system deployment because these components will make system interfaces easier to use and drive staff to adopt the system effectively (Venkatesh & Davis, 2000). The implementation of informatics as an enhancement tool which assists human decision-making and service compassion will protect service relationships and build customer confidence (Lusch & Nambisan, 2015).

The results indicate that managers need to use a flexible method which extends over time for their digital transformation initiatives. The process of continuous learning and service experimentation with iterative improvement must occur because it enables organizations to meet shifting customer needs and new technological developments (Kotler et al.,2021). Retailers who establish customer-oriented store environments and unite their staff between departments will achieve success through informatics-based development of customized shopping experiences.

5.3 Policy and Sector Implications

The findings indicate that the retail industry needs ongoing financial backing to develop digital competencies which should focus on supporting small and medium enterprises. Retailers understand the strategic value of informatics yet their attempts to implement it effectively encounter multiple barriers because they need better skills and they struggle with system integration and ethical governance (Retail NZ, 2023). The sector can improve its informatics-based customer experience innovation through policy programs which teach functional digital skills and service-based technology usage and responsible data management practices (MBIE, 2022).

The results extend their impact to situations which exist outside of New Zealand. The research findings from this study provide applicable knowledge which other small and medium sized economies can use to address their common retail sector problems with digital change and trust issues and inclusive practices. The research on responsible digital transformation (Vargo & Lusch, 2016; Huang & Rust, 2018) supports the focus on relational value creation and employee mediation and ethical governance practices.

The research results show organizations must treat informatics-based customer experience development as their fundamental business approach and organizational necessity. Retail systems will become more effective at serving all customers while remaining resilient to challenges through the implementation of technology adoption which follows relational service principles and builds employee competencies and upholds ethical governance.

5.4 Demographic Profile of Respondents

Respondents represented a range of key stakeholder groups within the retail ecosystem, including retail customers, retail employees, and retail business owners or managers. This distribution ensured that perspectives were captured across consumption, operational, and strategic levels of retail activity, providing a balanced and multi-dimensional understanding of informatics-enabled customer experience. The inclusion of diverse respondent roles supports the robustness of the analysis by reflecting how informatics technologies are perceived and utilised by different actors involved in retail service delivery and value co-creation.

The survey sample included respondents from a broad range of age groups, ensuring representation across multiple generations within the retail ecosystem. This diversity supports the analysis by capturing varying levels of digital familiarity, service expectations, and attitudes toward informatics-enabled retail experiences. The presence of both younger and older respondents provides a balanced basis for examining customer experience, trust, and value co-creation across different stages of technology adoption, without limiting the findings to a single generational perspective.

The survey results indicate variation in shopping frequency among respondents, reflecting different levels of exposure to retail technologies across online and physical channels. A substantial proportion of participants reported frequent engagement with retail environments, suggesting regular interaction with informatics-enabled systems such as digital payment solutions, loyalty platforms, and personalised service interfaces. Less frequent shoppers, while engaging with retail technologies to a lesser extent, provided complementary insights into how infrequent exposure shapes perceptions of usability, trust, and system value. Overall, the diversity in shopping frequency supports a more comprehensive understanding of how informatics systems influence customer experience across different patterns of retail engagement.

5.4.4 Perceptions of Personalization and Control

Respondents were asked to indicate their agreement with five statements that addressed whether a customer thought higher automation capabilities led them to be more satisfied and to feel an experience was personalized. Aggregated responses The combined responses suggest mixed attitudes:

Table 1. Perceptions of Personalization and Control among Survey Respondents

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I receive product recommendations that match my preferences	23	16	44	43	46
I get personalized discounts or promotions	21	23	41	55	30
I am addressed by name or recognized as a returning customer	24	27	44	46	31
My previous purchases are used to improve my future experience	29	24	35	52	33
The platform adapts to my shopping behaviour (e.g., saved preferences)	27	22	40	44	36

(Source: Author)

Key observations:

- The survey results show that customers mostly respond with neutral or disagreeable answers when asked about personalized recommendations and shopping behaviour-based adaptations.

- The low number of "Strongly Agree" responses indicates that personalization features either lack usage or do not provide sufficient value to customers.
- The results show that customers respond more positively to loyalty-based recognition through name addressing which indicates a moderate success in implementing basic CRM practices.

The paper demonstrates that technology deployment does not automatically translate into customer-perceived value because tools fail to create meaningful personalization experiences.

5.4.5 Anticipated Impact of Future Technologies

The survey participants assessed which new technologies would affect retail customer behaviour experience in the future. The survey participants ranked the following technologies as their top choices for future retail customer experience development:

Table 2. Anticipated Impact of Emerging Technologies on Retail Customer Experience

Technology	Strongly Agree	Agree	Total Positive Responses
Internet of Things (IoT)	25	96	121
Blockchain-based loyalty programs	29	92	121
Virtual Reality (VR)	28	91	119
Predictive Analytics	34	88	122
AR Shopping Experiences	26	88	114

Voice Commerce (e.g., Alexa)	37	84	121
AI-driven Customer Service	39	76	115

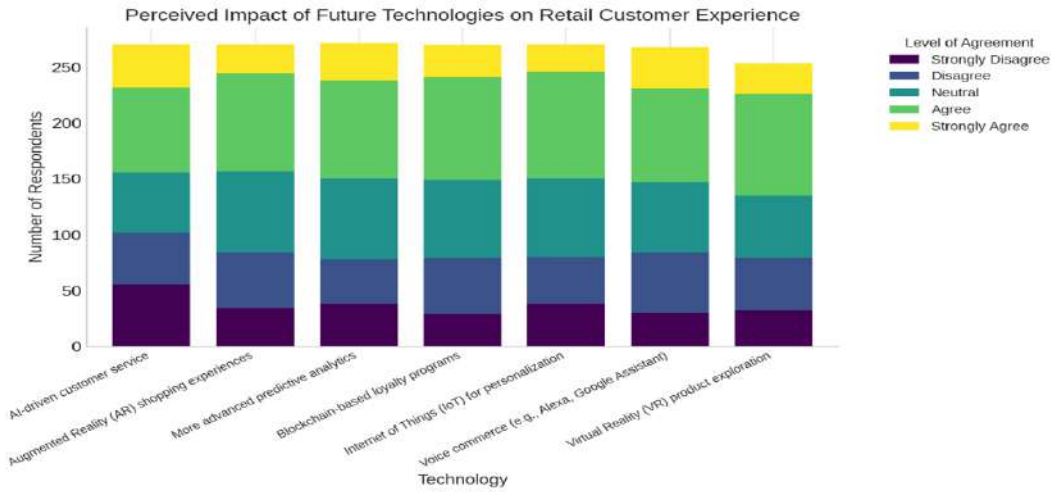
(Source: Author)

Notably:

- The highest optimism lies in IoT and predictive analytics, both of which underpin real-time personalization and behaviour tracking.
- Blockchain receives surprising support, reflecting growing interest in secure, transparent loyalty systems.
- Augmented Reality (AR) and Virtual Reality (VR) as a form of enhancing product exploration both AR and VR are considered as potentially valuable additions to the art of exploring products, even to non-professional customers.
- The new voice commerce shopping platform received positive feedback which suggests it will expand into hands-free retail markets in the future.

Figure 1.3 presents the respondents' agreement on the future effects of new technologies on retail trade.

Figure 1.3: Respondents' Agreement Levels on the Future Impact of Emerging Technologies in Retail



(Source: Author)

Overall, the findings tend to indicate that rather than being resistant due to fears of adaptation failures, clients and stakeholders are open to more advanced tools and technologies even if they are not yet in widespread packaged use.

4.4.6 Summary of Insights

- Not all tech is created equal: The majority of customers interact with chatbots and product recommendations but self-checkout and behavioural tracking tools remain underutilized which shows that informatics technology has only been partially implemented in retail environments.
- Perceived personalization is low: Users experience a significant disconnect between backend data systems and frontend execution because they do not receive personalized experiences despite having personalization engines in place.
- There is a great deal of hope for the future: The stakeholders from different roles show their belief in AI and IoT and AR/VR and blockchain technologies which creates a strategic chance to invest and develop new solutions.

4.5 Hypothesis Testing

Based on the integrated conceptual framework combining the TAM and SDL, this study proposed and tested three hypotheses to examine the role of informatics adoption in enhancing customer experience within New Zealand retail businesses. Quantitative survey data from retail managers were analysed to evaluate the hypothesised relationships, while qualitative insights from frontline employees were used to support and interpret the findings.

4.5.1 Hypothesis 1

H1: The perceived usefulness of informatics technologies positively influences their adoption by retail organisations in New Zealand.

The findings strongly support Hypothesis 1. Survey results indicate that retail managers are more likely to adopt informatics systems such as CRM platforms, AI-driven analytics, and customer data tools when these technologies are perceived to improve operational efficiency, service responsiveness, and customer personalisation. Respondents reported that systems enabling faster decision-making, improved customer segmentation, and enhanced service

consistency were viewed as strategically valuable. This finding aligns with TAM literature, which identifies perceived usefulness as a key determinant of technology adoption (Davis, 1989; Venkatesh & Davis, 2000). In the New Zealand retail context, perceived usefulness was particularly salient for organisations operating under resource constraints, as informatics investments were expected to deliver clear and measurable service outcomes.

4.5.2 Hypothesis 2

H2: The perceived ease of use of informatics technologies positively influences employee engagement with these systems in retail service delivery.

Hypothesis 2 is also supported by the empirical evidence. Quantitative results reveal a significant relationship between perceived ease of use and the extent to which frontline employees engage with informatics systems in daily service operations. Qualitative findings further indicate that employees were more willing to rely on CRM systems and analytics tools when interfaces were intuitive and aligned with existing workflows. Conversely, complex systems requiring extensive training or disrupting established service routines were often underutilised, despite their technical capabilities. These results reinforce TAM's emphasis on ease of use as a critical adoption factor, particularly in SME retail environments where staff workloads are high and training resources are limited.

4.5.3 Hypothesis 3

H3: The effective use of informatics technologies positively contributes to customer experience through value co-creation mechanisms.

The results provide strong support for Hypothesis 3. Retail organisations that successfully integrated informatics tools into their service design reported higher levels of customer satisfaction, trust, and engagement. From an SDL perspective, informatics functioned as an operant resource enabling value co-creation by facilitating personalised interactions, continuous dialogue, and responsive service adjustments. Case evidence from New Zealand retailers demonstrated that customer experience improvements were most pronounced when informatics systems supported relational service practices rather than purely transactional efficiency. This confirms SDL's assertion that value is co-created through interactions between customers, employees, and organisational systems (Vargo & Lusch, 2004; Lusch & Nambisan, 2015).

4.5.4 Summary of Hypothesis Evaluation

Overall, the hypothesis testing confirms that informatics technologies enhance customer experience in New Zealand retail businesses through a two-stage process. First, technology adoption depends on perceived usefulness and ease of use, as explained by TAM. Second, once adopted, informatics systems generate experiential value by enabling value co-creation, consistent with SDL principles. The findings highlight that technology adoption alone is insufficient; customer experience improvements occur only when informatics systems are embedded within service practices and supported by employee engagement and organisational readiness.

5. CONCLUSIONS

This article has examined how informatics technologies can be leveraged to enhance customer experience in New Zealand retail businesses, drawing on an integrated analytical framework that combines the TAM and SDL. The research demonstrates that informatics serves as a strategic resource which determines how value evolves throughout time in the digital retail sector which focuses on customer experiences.

The research produces multiple essential results which emerge from the study. Retailers achieve individualized customer experiences through personalization which operates as their primary operational mechanism based on informatics. Retailers can improve their customer service through CRM systems and data analytics and AI-driven tools which enable them to create individualized experiences that provide customers with easy and interactive interactions. The three core elements which enable personalization benefits include data quality and system integration and ethical governance systems because New Zealand's limited market size requires businesses to maintain customer trust and build positive corporate reputation (Davenport & Harris, 2017; Huang & Rust, 2018).

The research shows organizations need to build particular abilities and their personnel must function as connectors to obtain real advantages from their information technology system deployment. The Theory of Acceptance Model (TAM) demonstrates that managers together with frontline employees will implement informatics systems because they find these systems useful and easy to operate (Davis, 1989; Venkatesh & Davis, 2000). The research shows that organizations fail to improve customer experience through informatics investments because they do not provide adequate training and change management and service workflow integration. The customer experience process depends on employees as its main participants because informatics

works best when it functions as an additional tool which improves human decision-making and service relationships (Lusch & Nambisan, 2015).

The research shows that omnichannel integration serves as an essential factor which supports customers to experience continuous and unbroken shopping experiences. Businesses can maintain experiential continuity through customer data analysis from informatics systems which enables them to build relational value by showing inventory availability and managing service operations between physical stores and digital platforms. The implementation of various systems by retailers creates difficulties which lead to inconsistent customer experiences that negatively impact customer trust and satisfaction levels. The research findings validate SDL's method of continuous communication which generates value through its service network management operations (Vargo & Lusch, 2008; Storbacka et al.,2016).

The research shows that trust operates alongside ethical governance systems to establish vital conditions which enable informatics systems to deliver customer experiences. People who shop at retail stores now base their experience judgments on both operational effectiveness and their ability to see what happens with their information and experience equal treatment. The public moral standards which MBIE (2022) established guide New Zealand to build regulatory frameworks which promote digital competence and responsible data management practices. Retailers who establish ethical governance systems through their informatics approaches will create environments which enable long-term customer relationships and ongoing customer participation.

The research results create new knowledge because they demonstrate how TAM and SDL function together to study customer experiences via informatics systems within small and medium-sized retail sectors. The research shows how digital retail transformation generates customer experience results through the combination of technology adoption with organizational capability and relational service design elements.

This study highlights how informatics-enabled customer experience emerges from the interaction between technology adoption, organisational capabilities, and value co-creation mechanisms within the retail sector. By integrating Technology Acceptance Model (TAM) and Service-Dominant Logic (SDL), the research demonstrates that effective informatics adoption depends not only on technological readiness but also on employee engagement, ethical governance, and customer trust.

The findings offer important implications for retail practitioners and policymakers, emphasising the need to invest in digital capabilities, workforce development, and responsible data governance to support inclusive and

resilient retail systems. Future research should further examine how informatics adoption and customer experience evolve over time, particularly across different institutional, cultural, and industry contexts, to enhance understanding of value creation in digitally transforming service ecosystems.

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Green Training, Development and Green Innovations: Linking Two Emerging Agendas

TWDSP Somarathna

ABSTRACT

"Go Green", a simple yet a controversial concept, leads an organization into Social Corporate Responsibility. The aims of this study were to find the impact of Green Training and Green Development on Green Product Innovations, Green Process Innovations and Green Managerial Innovations of a firm. Quantitative analysis was used with convenience sampling method and data was collected through semi structured questionnaire with 10-point itemized scale. Collected data for the Quantitative analysis was analysed using SPSS version 25. The study revealed that Green Training is significant for Green Product Innovation, Green Process Innovation and Green Managerial Innovation. Green Development is significant for Green Managerial Innovation, while insignificant for Green Product Innovation and Green Process Innovation. KMO and Bartlett's test result showed the sample adequacy of 0.63 and aggregate Cronbach's alpha value of 0.875. Further it revealed that Green Training and Green Development have the ability to account for variations in Green Product Innovation by 40.2 percent., Green Process Innovation by 35.6 percent and Green Managerial Innovation by 93.5 percent. The results also present several implications for managers and provide some suggestions for future researches.

Keywords: *Green Training, Green Development, Green Product Innovation, Green Process Innovations, Green Managerial Innovations*

1. INTRODUCTION

In contemporary competitive markets, organizations increasingly emphasized a strong customer orientation by designing products and services that aligned closely with evolving customer needs and expectations. Beyond traditional market-driven strategies, firms progressively recognized that long-term competitiveness depended not only on customer satisfaction but also on their broader social and environmental responsibilities. As a result, corporate strategies increasingly incorporated sustainability-oriented practices, particularly the adoption of green initiatives, as a response to stakeholder pressure, regulatory requirements, and global environmental challenges (Dangelico & Vocalelli, 2017).

Achieving Sustainable Competitive Advantage (SCA) remained a central objective for organizations seeking long-term survival and superior performance. Sustainable competitive advantage referred to a firm's ability to generate value that competitors could not easily replicate over time. Recent studies demonstrated that firms pursuing sustainability-driven strategies, such as eco-innovation, environmental management systems, and green human capital development achieved superior financial, operational, and reputational outcomes (Teece, 2018; Xie et al., 2022). For example, manufacturing firms that embedded environmental practices into their core operations reported enhanced efficiency, reduced costs, and stronger brand legitimacy (Singh et al, 2020).

The Resource-Based View (RBV) theory (Barney, 1991), of the firm provided a foundational explanation for sustainable competitive advantage by positing that firms achieved superior performance when they possessed resources that were valuable, rare, inimitable, and non-substitutable. Building on this perspective, contemporary research extended RBV to sustainability contexts by highlighting that intangible resources, such as environmental knowledge, green capabilities, and organizational learning played a critical role in long-term competitiveness (Barney et al., 2011). However, scholars argued that traditional RBV inadequately captured the strategic importance of environmental constraints and ecological resources.

Addressing this limitation, Hart (1995) introduced the Natural Resource-Based View (NRBV), which emphasized the strategic role of environmental capabilities in shaping competitive advantage. Recent empirical studies demonstrated that firms achieved superior performance when internal resources and capabilities were aligned with environmental stewardship, pollution prevention, and sustainable resource use (Andersén, 2021; Rehman et al., 2024). Evidence from manufacturing and service sectors indicated that proactive environmental strategies strengthened firm resilience, innovation capacity, and market differentiation (Kraus et al., 2020).

In pursuit of sustainable competitive advantage, organizations increasingly integrated environmentally friendly practices across their operations. Rather than treating sustainability as a peripheral activity, firms embedded environmental objectives into strategic decision-making, human resource systems, and innovation processes. Empirical evidence showed that Green Human Resource Management (GHRM) practices, including green training, green development, and employee environmental involvement, supported the development of firm-specific green capabilities that were difficult for competitors to imitate (Pham et al.,2022; Renwick et al., 2013). These practices enhanced employees' environmental competencies and facilitated the translation of sustainability strategies into operational outcomes.

Recent studies further demonstrated that employee involvement, leadership commitment, and environmental awareness positively influenced organizational environmental performance. For instance, environmentally focused leadership and structured green training programs improved employees' pro-environmental behaviours, leading to enhanced eco-efficiency and reduced environmental impact (Katz et al., 2022; Maheshwari et al., 2024). Such human-centered approaches enabled organizations to convert sustainability intentions into tangible performance improvements.

Another strategic pathway to sustainable competitive advantage involved green innovation, which encompassed innovations in products, processes, and managerial practices aimed at reducing environmental harm while improving resource efficiency. Contemporary literature defined green innovation as the development or adoption of new or significantly improved solutions that minimized environmental impact across the product life cycle (Chen et al., 2020). Empirical research consistently showed that green innovation enhanced both environmental and economic performance by lowering costs, improving operational efficiency, and strengthening market positioning (Singh et al., 2020; Xie et al., 2022).

Accordingly, this study examined the impact of Green Training and Green Development on Green Product Innovation, Green Process Innovation, and Green Managerial Innovation within influential sectors and leading brands in Sri Lanka. By addressing this gap, the study contributed empirical evidence on how human resource–driven green capabilities supported sustainable competitive advantage in emerging market contexts.

1.1 Research Question

Based on the problem statement developed as above, the following research question is to be addressed.

i) What is the relationship between Green Training and Development and Green Innovation?

1.2 Research Objective

According to the research question, the following objective is organized.

i) To identify the impact of Green Training and Development on Green Innovations

2. LITERATURE REVIEW

2.1 Green Training and Development

Green Training and Development (GTD) has been identified as a core dimension of Green Human Resource Management that supports organizational environmental objectives by enhancing employees' environmental knowledge, skills, and attitudes (Juhari Noor Faezah et al., 2024; Renwick et al., 2013). Green training referred to structured learning activities aimed at improving employees' understanding of environmental protection, regulatory compliance, and sustainable resource utilization within organizational operations (Pham et al., 2022).

Empirical evidence indicated that green training programs increased employees' pro-environmental awareness and enabled the adoption of environmentally responsible work practices, including waste minimization, energy conservation, and pollution prevention behaviours (Bangwal et al., 2025; Vadithe et al., 2025). Such practices supported the implementation of organizational environmental management systems and contributed to improved environmental performance outcomes (Katz et al., 2022).

Green development extended beyond short-term training initiatives and focused on long-term capability building through environmental knowledge management, leadership development, and continuous learning mechanisms. Prior studies showed that green development initiatives enhanced employees' competencies in addressing complex environmental management challenges and facilitated the integration of sustainability values into organizational culture (Juhari Noor Faezah et al., 2024; Yong et al., 2019). Consequently, organizations investing in green training and development were better positioned to develop firm-specific green capabilities that supported sustained environmental and competitive performance (Renwick et al., 2013).

2.2 Green Innovation

Green innovation has been widely recognized as a strategic response to increasing environmental pressures and sustainability demands faced by organizations. Contemporary literature defined green innovation as the development or adoption of new or significantly improved products, processes, or managerial practices that reduced environmental impact across the product life cycle (Bossle et al., 2021; Chen et al., 2020;).

Empirical studies consistently reported that green innovation contributed to both environmental and economic performance by improving resource efficiency, reducing environmental costs, and enhancing corporate reputation (Singh et al.,

2020; Xie et al., 2022). Furthermore, green innovation enabled firms to meet regulatory requirements and respond to growing stakeholder expectations for sustainability (Aboelmaged & Hashem, 2019). Based on these characteristics, green innovation has commonly been categorized into green product innovation, green process innovation, and green managerial innovation (Andersén, 2021).

2.3 Green Product Innovation

Green product innovation referred to the development or substantial improvement of products designed to minimize environmental harm throughout their life cycle. Recent studies described green product innovation as changes in product design, material composition, or functional attributes aimed at reducing energy consumption, emissions, and the use of hazardous substances (Chen et al., 2020; Dangelico & Vocalelli, 2017).

Empirical research showed that organizations implementing green product innovations adopted recyclable or biodegradable materials, extended product durability, and improved energy efficiency to comply with environmental regulations and respond to increasing consumer demand for sustainable products (Kraus et al., 2020; Singh et al., 2020). These product-level innovations were found to reduce environmental footprints while strengthening market differentiation and customer trust (El-Kassar & Singh, 2019).

2.4 Green Process Innovation

Green process innovation involved the improvement or redesign of production and operational processes to reduce environmental impact. Contemporary literature defined green process innovation as the adoption of cleaner production technologies, eco-efficient manufacturing systems, and waste-reduction mechanisms within organizational processes (Andersén, 2021; Xie et al., 2022).

Prior empirical studies indicated that green process innovation reduced material and energy consumption, lowered emissions, and improved overall eco-efficiency (Aboelmaged & Hashem, 2019). Moreover, firms implementing green process innovations achieved improved environmental and operational performance when such initiatives were supported by employee environmental training and organizational learning systems (Chen et al., 2020; Vadithe et al., 2025).

2.5 Green Managerial Innovation

Green managerial innovation referred to the adoption of environmentally oriented managerial practices, policies, and systems that integrated sustainability considerations into organizational decision-making processes. Recent research defined green managerial innovation as the redesign of governance structures, performance evaluation systems, and strategic planning frameworks to incorporate environmental objectives (Juhari Noor Faezah et al., 2024;Singh et al., 2020).

Examples of green managerial innovation included the implementation of formal environmental management systems, sustainability-based performance indicators, and environmentally responsible supplier collaboration practices, all of which have been empirically linked to improved environmental coordination and organizational commitment to sustainability (Bangwal et al., 2025; Xie et al., 2022). These managerial innovations supported the institutionalization of sustainability practices and contributed to long-term organizational performance.

3. METHODOLOGY

3.1 Conceptual Framework

Based on their hypothetical behavioural pattern, the proposed conceptual framework is depicted in Figure 01 below.

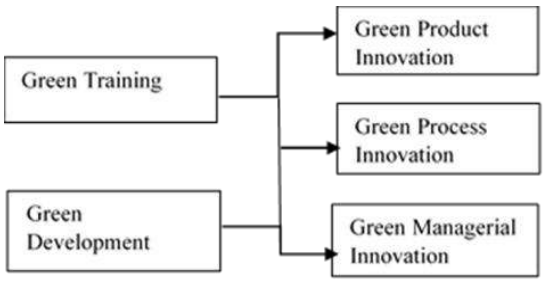

Figure 1: Conceptual Framework *(Source: Author)*

3.2 Formulation of Empirical Model

The formulation of the empirical model of the research was developed based on the conceptual framework of the study, as shown below

$Y_{1ij} = f$x (X1ij, X2ij) err

$Y_{2ij} = f$x (X1ij, X2ij) err

$Y_{3ij} = f$x (X1ij, X2ij) err

Where:

ij = Opinion of an Employee in an Organization

X_1 = Vector of Green Training

X_2 = Vector of Green Development

Y_1 = Vector of Green Product Innovations

Y_2 = Vector of Green Process Innovations

Y_3 = Vector of Green Managerial Innovations

3.3 Sample Profile

The study population consisted of executive-grade employees drawn from four major industries in Sri Lanka: the hotel, banking, dairy, and telecommunication industries. In the hotel sector, Jetwing Hotels, John Keells Hotels, and Aitken Spence Hotels were selected based on their high ratings on widely used booking platforms such as TripAdvisor, Expedia, Booking.com, and Agoda. Within the banking sector, two state-owned banks (Bank of Ceylon and People's Bank) and three private commercial banks (Commercial Bank, Hatton National Bank, and Sampath Bank) were selected based on their reported profit before taxation, all exceeding LKR 15 billion in the most recent financial year. For the dairy industry, Highland and Fonterra were selected due to their publicly reported commitments to environmental protection, as disclosed in corporate sustainability reports and official websites. In the telecommunication sector, Dialog Axiata PLC and Mobitel (Pvt) Ltd were selected as market leaders in Sri Lanka. A convenience sampling technique was employed, and data were collected from a total of 140 respondents across the selected organizations.

3.4 Data Collection Method

Primary data were collected using a semi-structured questionnaire administered to executive level employees in the selected organizations. The questionnaire employed a 10-point itemized rating scale to measure respondents' perceptions of Green Training, Green Development, and Green Innovation practices.

3.5 Data Analytical Method

The collected data were analysed systematically using SPSS version 25 and Microsoft Excel. Univariate analysis was conducted to identify response patterns across industries and organizations. Sampling adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's Test of Sphericity. The internal consistency and reliability of the measurement scales were evaluated using Cronbach's Alpha. To examine the relationships between the independent and dependent variables, a Generalized Multivariate Model was employed to assess model fit, goodness-of-fit indices, and parameter estimates.

4. RESULTS

4.1 Sample Characteristics

Among 140 sample elements, only 127 responded. The Table1 shows the number of respondents from each industry.

Table 1. Number of Respondents from Each Industry

Industry	No of respondents
Banking	41
Hotel	37
Telecommunication	21
Dairy	28
Total	127

(Source: Author)

4.2 Univariate Analysis

In univariate analysis it was found that Jetwing Hotels got most favourable responses for all indicators in Hotel Industry while Bank of Ceylon got most favourable responses for all indicators in Banking Industry. Accordingly, Milco got most favourable responses for all indicators in Dairy Industry. In Telecommunication Industry it cannot be identified among Dialog and Mobitel which company got most favourable responses.

4.3 Sample Adequacy

The Kaiser-Meyer Olkin (KMO) and Bartlett's Test measure of sampling adequacy is used to test the suitability of Factor Analysis.

Table 2. Sampling Adequacy- KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.633
Bartlett's Test of Sphericity	Approx. Chi-Square	1076.341
	df	10
	Sig.	.000

(Source: Author)

According to the Table 2, The approximate of Chi-square is 1076.341with 10 degrees of freedom, which is significant at 0.05 Level of significance. The KMO statistic of 0.633 is also large (greater than 0.50). Hence Factor Analysis is considered as a suitable method for further analysis of the data. And also, it indicates 63.3 percent changes of the population can be seen in the sample.

4.4 Reliability Test

Upon finding the sample is well adequate, the sample was then checked for its reliability. The Sample reliability was tested using Cronbach's alpha and the Aggregate value obtained was 0.875 for the five variables. It can be identified that 87.5 percent of the sample results can be generalized to the whole population.

4.5 Model Fit

The Test of Between-Subject Effect is used to find the Model Fit (using level of significance) and to find the amount of contribution of an independent variable in order to change a dependent variable (using R squared values). The Model fit shows whether the relationship between an independent variable and a dependent variable is properly fit for the study. The results of Tests of between subject effects is shown in Table 03 below.

Table 3. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Green Product Innovation	6897.788[a]	2	3448.894	41.650	0.000
	Green Process	7841.467[b]	2	3920.734	34.241	0.000

	Innovation					
	Green Managerial Innovation	10755.116[c]	2	5377.558	897.169	0.000
a. R Squared = .402 (Adjusted R Squared = .392)						
b. R Squared = .356 (Adjusted R Squared = .345)						
c. R Squared = .935 (Adjusted R Squared = .934)						

(Source: Author)

According to the Table 3, it can be identified that the variables considered are fit for the study. Green Training and Green Development have the ability to account for variations in Green Product Innovation by 40.2 percent., Green Process Innovation by 35.6 percent and Green Managerial Innovation by 93.5 percent.

4.6 Parameter Estimates

Parameter Estimates is used to find the impact of each independent variable on dependent variables of the Qualitative analysis. The Beta values (B) show how strongly each independent variable influences the dependent variable. Below Table 04 shows the Parameter estimates or coefficients of the model.

Table 4. Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	Intercept	13.106	2.491	5.262	0.000	8.177	18.036
Green Product Innovation	Green Training	0.6	0.081	7.5	0.0	0.447	0.767

		0 7		0 1	0 0		
	Green Development	0.017	0.084	0.2	0.842	-0.149	0.182
Green Process Innovation	Intercept	19.249	2.929	6.573	0.000	13.452	25.046
	Green Training	0.657	0.095	6.898	0.000	0.468	0.845
	Green Development	0.001	0.098	0.009	0.993	-0.194	0.195
Green Managerial Innovation	Intercept	-0.666	0.67	-0.985	0.327	-1.986	0.666
	Green Training	0.12	0.022	5.523	0.000	0.077	0.163
	Green Development	0.719	0.022	31.987	0.000	0.675	0.764

(Source: Author)

As per the Table 04 it can be observed that a change of one odd number (one standard deviation) in Green Training will result in a change of 0.607 in Green Product Innovation, 0.657 in Green Process Innovation and 0.12 in Green Managerial Innovation. Consequently, a change of one odd number in Green Development will result in a change of 0.017 in Green Product Innovation, 0.001 in Green Process Innovation and 0.719 in Green Managerial Innovation. Further it can be seen that the impact of Green Development on Green Product Innovation and Green Process Innovation are insignificant.

5. DISCUSSION

Organizations increasingly integrated environmental considerations into their long-term business strategies in response to regulatory pressures, stakeholder expectations, and global sustainability challenges. Recent empirical studies showed that firms addressing environmental issues strategically invested in intellectual capital, research and development, and human resource practices to support environmental innovation and sustainable performance (Teece, 2018; Singh et al., 2020). In particular, Green Training and Development practices were found to play a significant role in directing employee capabilities toward environmentally responsible behaviours and innovation outcomes (Bangwal et al., 2025; Renwick et al., 2013).

Contemporary management literature continued to recognize the relevance of managerial skill classifications originally proposed by Katz (1955), while extending and empirically validating them in modern organizational contexts. Recent studies reaffirmed that technical, interpersonal, and conceptual skills remained foundational managerial competencies, but emphasized their dynamic and integrated nature in knowledge-intensive and sustainability-oriented organizations (Aboelmaged & Hashem, 2019; Yukl & Gardner, 2020). Technical skills were associated with task-specific expertise, process knowledge, and the application of specialized tools, whereas conceptual skills involved systems thinking, strategic reasoning, and the ability to integrate environmental considerations into organizational decision-making (Teece, 2018; Yukl & Gardner, 2020).

The distinction between training and development has been revisited in recent human resource research, with scholars noting that training and development differed primarily in scope and orientation rather than being strictly separated by time horizon. Empirical evidence suggested that training tended to focus on enhancing job-related competencies and operational effectiveness, while development emphasized broader capability building, leadership growth, and long-term adaptability (Garavan et al., 2012; Noe et al., 2021). However, contemporary studies also highlighted overlap between training and

development, particularly in sustainability contexts, where training initiatives frequently incorporated developmental elements such as problem-solving, environmental awareness, and strategic thinking (Juhari Noor Faezah et al., 2024;Renwick et al., 2013).

The findings of the present study aligned with recent green innovation literature, which demonstrated that Green Product Innovation and Green Process Innovation relied heavily on employees' technical expertise, operational knowledge, and process-oriented competencies. Prior empirical research showed that product and process-level environmental innovations required proficiency in production technologies, material efficiency, and environmental control systems (Andersén, 2021;Chen et al., 2020). These competencies were most effectively supported through structured green training initiatives that enhanced employees' technical and operational capabilities.

In contrast, Green Managerial Innovation was more strongly associated with conceptual and integrative skills, including strategic decision-making, cross-functional coordination, and sustainability-oriented leadership. Recent studies indicated that managerial-level green innovations depended on the ability to align environmental objectives with organizational strategy, governance structures, and stakeholder engagement processes (Singh et al., 2020; Xie et al., 2022). Nevertheless, empirical evidence also suggested that sound technical understanding remained essential for effective green managerial decision-making, particularly when evaluating technological feasibility and environmental trade-offs (Teece, 2018; Yukl & Gardner, 2020).

The Sri Lankan apparel sector provided practical evidence supporting these relationships. For instance, MAS Holdings implemented dedicated research and innovation functions to address environmental challenges associated with production processes through green innovations. Publicly available sustainability reports and independent studies documented MAS Holdings' investments in green technologies, eco-efficient manufacturing processes, and employee development programs aimed at fostering environmental innovation and sustainability-oriented skills (MAS Holdings, 2022; Wijethilake & Lama, 2018). These initiatives illustrated how a supportive work environment and structured green development practices contributed to the enhancement of organizational intellectual capital and green innovation outcomes.

Overall, the discussion supported the study's findings that Green Training exerted a stronger influence on Green Product and Green Process Innovation, while both Green Training and Green Development contributed to Green Managerial Innovation. These results were consistent with contemporary theoretical and empirical literature, reinforcing the role of human capital development as a critical driver of green innovation and sustainable competitive advantage.

6. CONCLUSIONS

Intangible resources, such as organizational knowledge, capabilities, and intellectual capital were increasingly recognized as critical foundations of sustainable competitive advantage, particularly when firms sought to create and appropriate value in changing competitive and stakeholder environments (Barney et al., 2011). Consistent with this view, green human resource management research has shown that building employees' environmental competencies through structured Green Training and longer-horizon Green Development practices supported the formation of firm-specific green capabilities that were difficult to imitate (El-Kassar & Singh, 2019; Renwick et al., 2013).

Based on the empirical results of this study, organizations that reported stronger Green Training and better opportunities for Green Development also exhibited higher levels of Green Product Innovation, Green Process Innovation, and Green Managerial Innovation relative to other firms in their respective markets. This conclusion aligned with recent evidence showing that green HRM practices enhanced sustainable performance partly by enabling green innovation outcomes and strengthening employees' environmental engagement (El-Kassar & Singh, 2019; Zihan, 2024). Moreover, prior empirical studies indicated that green innovation contributed to both environmental and competitive outcomes by improving resource efficiency and strengthening strategic differentiation (Andersén, 2021; Chen et al., 2020).

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Banking Beyond the Counter: Assessing Online Customer Satisfaction of Kiwibank Customers

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ABSTRACT

The COVID-19 pandemic accelerated digital transformation across industries, reshaping how businesses engage with customers. As lockdowns and mobility restrictions intensified, organisations rapidly transitioned to online platforms to maintain continuity and service delivery. Banking, already partway through a digital shift, experienced a near-total migration to online operations during this period. This study examined customer satisfaction with online banking services at Kiwibank in New Zealand, during the pandemic. It focused on customers' perceptions of usability, service quality, and the factors influencing overall satisfaction. Using a qualitative approach, the research gathered insights from 20 customers and applied thematic analysis aligned with the study's objectives. Findings revealed that 95% of participants relied on online banking during lockdowns. Most reported positive experiences, highlighting ease of use, seamless transfers, intuitive interfaces, responsive services, and improved digital design. Reliability and efficiency emerged as key drivers of trust and customer advocacy, with many participants willing to recommend the bank to others. However, challenges were identified, particularly around money transfers, including confirmation processes and transactional clarity. The study suggests that enhancing user guidance, such as brief digital tutorials and clear step-by-step prompts, could further improve customer experience. While limited by its small sample size, the research offers practical insights for strengthening digital banking strategies in an increasingly online-first environment.

Keywords: *Online banking, Customer satisfaction, Kiwibank, Thematic analysis*

1. INTRODUCTION

Rapid technological advancement has fundamentally reshaped the global banking industry, redefining how financial institutions deliver services and how customers interact with them (Oyeyemi, 2025). Among the most significant transformations is the widespread adoption of online banking, also referred to as internet banking, e-banking, or virtual banking (Haq & Awan, 2020). Online banking enables

customers to conduct financial transactions electronically through internet-enabled platforms, thereby reducing reliance on traditional branch-based banking systems. These systems facilitate a wide range of activities, including balance inquiries, fund transfers, bill payments, and account management, all of which are supported by core banking infrastructures (Garepasha et al., 2020).

The transition from conventional branch banking to online banking has been driven by efficiency, cost reduction, and customer convenience (Adiguze et al, 2023). Traditional banking processes are often time-consuming and constrained by physical location and operating hours. In contrast, online banking offers customers continuous access to financial services, enabled through secure authentication mechanisms such as unique account credentials and one-time passwords. Contemporary online banking platforms include Automated Teller Machines (ATMs), personal computer banking, email banking, and increasing dominance of mobile and phone-based banking applications (Al-Sharafi et al., 2017). These developments highlight the strategic role of information and communication technologies (ICTs) in enhancing banking productivity and service delivery.

1.1 Online Banking Service Quality and Customer Satisfaction

Despite its operational advantages, the success of online banking depends largely on customer perceptions of service quality, trust, and usability, as has been found in previous studies such as (Amin, 2016) and (Ayo, 2016). Research consistently demonstrates that customer satisfaction in online banking environments is influenced by multiple dimensions of electronic banking service quality (EBSQ), including reliability, security, privacy, website or application design, and customer support (Blut et al., 2014; Haq & Awan, 2020). Shankar and Jebarajakirthy (2019) emphasise that trust between financial institutions and customers is a foundational determinant of online banking adoption and loyalty. Without sufficient trust, customers may perceive online platforms as risky, particularly in relation to data privacy and transaction security.

Service quality models applied to e-banking contexts suggest that improved system functionality, intuitive design, and timely service delivery contribute significantly to customer satisfaction (Amin, 2016). Ease of use, reduced transaction time, and system responsiveness have been identified as key drivers of positive customer experiences (Black et al., 2014). Electronic service quality shapes customers' attitudes toward banking technologies and influences their intention to continue using online services (Bressolles et al., 2014). E-satisfaction, defined as customers' affective and cognitive evaluation of online service experiences, has been linked to attitudinal loyalty and repeat usage

behaviour (Giao et al., 2020). Studies further indicate that technical factors such as internet speed, platform stability, and system availability play a critical role in shaping satisfaction levels (Suariedwei & Suprapti, 2020). Consequently, online banking service quality not only affects immediate customer satisfaction but also long-term trust, loyalty, and institutional reputation.

1.2 Privacy, Security, and Trust in Online Banking

Privacy and security concerns have historically represented major barriers to online banking adoption (Oyewole et al, 2024). The absence of face-to-face interaction raises customer anxiety regarding data confidentiality and potential cyber threats (Shankar & Jebarajakirthy, 2019). However, evolving regulatory frameworks and institutional codes of conduct have increasingly prioritised data protection, contributing to improved customer confidence (Orel & Kara, 2014). Research suggests that reliability, security, and privacy form the core pillars of online banking trust (Haq & Awan, 2020). Customers are more likely to engage with online banking platforms when they perceive transactions as secure and personal data as adequately protected (Muturi et al., 2013). Liang and Pei-Ching (2015) argue that system efficiency - particularly fast transaction processing and minimal system downtime - is essential for sustaining satisfaction. Thus, online banking success depends on a complex interplay between technological performance, institutional integrity, and perceived service quality. All of these factors shape customer perception and the decision to use online banking tools.

1.3 Impact of COVID-19 on Online Banking Adoption

COVID-19 pandemic accelerated the global shift toward digital banking, as lockdowns and social distancing measures limited access to physical bank branches. During this period, online banking became not only a convenience but a necessity. Financial institutions were compelled to rapidly scale their digital infrastructure to ensure service continuity while maintaining customer satisfaction and trust (Haq & Awan, 2020). Empirical evidence suggests that the pandemic positively influenced customer loyalty toward online banking, particularly where platforms were user-friendly and secure (Oyewole et al, 2024). Customers increasingly relied on mobile applications and websites to conduct essential financial activities, resulting in sustained growth in digital transactions. The sudden surge in online usage also exposed vulnerabilities related to system resilience, cybersecurity, and service reliability.

1.4 The New Zealand Context and Kiwibank

In New Zealand, the pandemic significantly increased reliance on electronic payment systems. Contactless card payments at points of sale increased by approximately 39% between 2018 and 2020, reflecting heightened consumer trust in digital financial technologies (Granwal, 2021). Kiwibank, established in 2001 as a major domestic financial institution, experienced substantial growth in online banking usage during periods of branch closure. The bank reported increased lending activity and profitability during the pandemic, earning recognition as a certified B Corporation, reflecting its commitment to ethical and customer-focused practices (Libatique, 2020; Stock, 2021).

Despite these achievements, Kiwibank faced notable challenges related to service reliability and security. In 2021, the bank experienced intermittent service outages, including a distributed denial-of-service (DDoS) attack, which disrupted customer access and raised concerns regarding data security and institutional preparedness (Edmunds, 2021). These incidents negatively affected customer satisfaction, with reports indicating that a significant proportion of customers considered switching banks. Allegations related to historical overcharging further intensified customer dissatisfaction and scrutiny of the bank's service quality (Tibshraeny, 2021).

1.5 Research Problem and Objectives

Given the heightened dependence on online banking during the COVID-19 pandemic, maintaining high levels of customer satisfaction has become a strategic imperative for financial institutions. In the case of Kiwibank, service disruptions and security concerns have challenged customer trust and loyalty, highlighting gaps between technological adoption and perceived service quality. Although online banking offers efficiency and convenience, a segment of customers remains hesitant due to usability challenges, lack of technological familiarity, and security concerns (Ling & Ismail, 2021).

This study sought to investigate how customer satisfaction with online banking can be attained and sustained at Kiwibank, even after the COVID-19 pandemic. Specifically, the research examines customers' perceptions of online banking usability and identifies key determinants - such as trust, security, reliability, and service quality - that influence satisfaction in a crisis context. By addressing these issues, the study aimed to contribute to both academic literature and managerial practices, offering insights into how banks can strengthen digital service delivery, enhance customer confidence, and ensure long-term sustainability in an increasingly digital financial landscape.

1.6 Research Question

How could customer satisfaction for online banking be attained by Kiwi Bank in a time of pandemic COVID-19?

1.7 Sub-Questions:

i. How do Kiwi bank customers perceive the usability of online banking?
ii. What are the determinants that enhance customer satisfaction using technology for online banking in the time of the pandemic?

1.8 Research Objectives

The key objectives of this research are mentioned below:

- To evaluate the customers' perception of Kiwi Bank on the online banking usability in COVID-19.
- To identify the determinants that improve the satisfaction of the Kiwi bank's customers for online banking in the pandemic.
- To determine whether the quality of online banking services impacts the satisfaction of the Kiwi bank's clients in the time of the pandemic.

2. LITERATURE REVIEW

This section critically reviews existing scholarship on online or net banking, customer satisfaction, and the impact of the COVID-19 pandemic on banking service delivery. By integrating theoretical and empirical studies, it seeks to establish how online banking service quality influences customer satisfaction and loyalty, with particular attention to usability, trust, security, and technological acceptance. This section concludes by identifying a research gap concerning customer experiences of online banking in the context of Kiwibank during the COVID-19 pandemic.

2.1 Customer Satisfaction in Online Banking

Customer satisfaction is a central construct in service-based industries, particularly banking, where long-term profitability and sustainability depend heavily on customer perceptions and experiences. Online banking has emerged as a strategic tool to enhance customer satisfaction by offering convenience, accessibility, and time efficiency (Banu et al., 2019). As digital technologies increasingly permeate banking operations, customer satisfaction is shaped not only by service outcomes but also by the quality of electronic service delivery.

Empirical studies consistently identify service quality as a key determinant of customer satisfaction in online banking. Ling et al. (2016), in a study of Malaysian banking customers, found that website design, convenience, and transaction speed significantly influence satisfaction levels. Similarly, Sakhaei et al. (2014) demonstrated that dimensions such as website design, security and privacy, efficiency, reliability, and responsiveness positively affect customers' satisfaction with net banking services, with website design emerging as the most influential factor.

Other studies highlight the importance of information availability and system functionality. Riyazahamed (2019) found that easy access to accurate and timely information motivates customers to adopt and continue using online banking services. However, technical issues such as system errors, service interruptions, and security vulnerabilities negatively affect customer perceptions and satisfaction (Asiyanbi & Ishola, 2018). Lack of awareness and trust also remains a barrier among non-adopters (Choudhuri, 2024), indicating the need for banks to improve communication and customer education. Existing literature further suggests that customer satisfaction in online banking is influenced by usability, perceived usefulness, security, reliability, privacy, and accessibility (Surendran & Acharya, 2021). Chu et al. (2012) argue that service quality not only encourages adoption but also enhances satisfaction and continued usage. Likewise, Liébana-Cabanillas et al. (2013) identify trust and ease of use as critical enablers of frequent e-banking usage. Collectively, these studies confirm that customer satisfaction in online banking is multidimensional and highly dependent on perceived service quality.

2.2 Net Banking and Service Quality

Net banking refers to the delivery of banking services through internet-enabled platforms that allow customers to perform financial transactions remotely (Dolinskaya, 2024). The adoption of net banking has transformed banking operations by reducing operational costs and increasing service efficiency (Keskar & Pandey, 2018). Since its introduction in the 1990s, online banking has evolved into a dominant service delivery channel, enabling customers to access banking services anytime and anywhere (Ling et al., 2021). Several studies emphasise the role of usability and perceived usefulness in driving net banking adoption. Nayanajith et al. (2019) found that perceived usefulness, web usability, and interactive features significantly influence customers' acceptance of internet banking. Similarly, Li et al. (2021) note that advancements in information and communication technologies have expanded banking accessibility and improved customer engagement.

From an institutional perspective, net banking provides competitive advantages by lowering transaction costs and enhancing customer loyalty. Takieddine and Sun (2015) report that banks adopting online banking models achieve substantial cost reductions and, in some cases, reduced dependence on physical branches. For customers, net banking offers convenience, time savings, and simplified financial management. Sasono et al. (2021) demonstrate that online banking service quality has a significant positive impact on both customer satisfaction and loyalty. Service quality in net banking is commonly evaluated through dimensions such as reliability, assurance, empathy, responsiveness, system availability, and security (Amin, 2016). Dhayanidhi (2021) adds that ease of understanding, quick service, and technological simplicity are crucial for attracting and retaining online banking users. These findings indicate that while net banking enhances efficiency, its success is contingent upon high service quality and positive user experiences.

2.3 Impact of the COVID-19 Pandemic on Online Banking

The COVID-19 pandemic profoundly disrupted traditional banking operations, accelerating the shift toward digital banking channels. Lockdowns and social distancing measures significantly reduced access to physical bank branches, compelling banks and customers to rely heavily on online banking services (Marcu, 2021). As a result, net banking transitioned from an optional convenience to an essential service. The pandemic forced banks globally to operate remotely while maintaining uninterrupted service delivery through digital platforms (Perwej, 2020). Despite operational challenges, online banking enabled banks to function efficiently during branch closures.. Baicu et al. (2020), in a study of retail banking customers, found that the pandemic significantly increased the adoption of mobile and internet banking. The authors recommend customer education initiatives to enhance digital literacy and engagement.

Behavioural studies during the pandemic frequently apply the Technology Acceptance Model (TAM) (1989) and Theory of Planned Behaviour (TPB) (Ajzen, 1985) to explain changes in customer attitudes. Sudarsono et al. (2020) found that perceived usefulness and ease of use positively influenced customers' acceptance of online banking during COVID-19. Concerns over virus transmission through physical currency encouraged customers to adopt digital payment and banking solutions (Wójcik & Ioannou, 2020). In the New Zealand context, banks responded to the pandemic by strengthening digital infrastructure, enhancing cybersecurity, and ensuring operational resilience (KPMG, 2020). These measures contributed to increased acceptance and reliance on online

banking, reinforcing its role as a critical component of financial service delivery during crises.

2.4 Bank Customers, Trust, and Online Banking Adoption

Bank customers play a pivotal role in the success of net banking initiatives. Online banking eliminates geographical and temporal constraints, allowing customers to access services conveniently (Tunay et al., 2015). However, customer adoption varies across demographic and socio-economic groups. Studies from developing regions indicate that security concerns and lack of trust hinder online banking adoption, particularly among rural and less technologically literate populations (Ramavhona & Mokwena, 2016). Trust and perceived ease of use are consistently identified as critical determinants of online banking adoption (Wu et al., 2010). Declining trust levels among banking customers in developed economies, on the other hand, negatively affect online banking uptake (Yu and Asgarkhani, 2015). In contrast, research suggests that New Zealand customers generally demonstrate positive attitudes toward technology and online banking services (Watson, 2016). Ofori et al. (2017) argue that trust must be continuously built through consistent service quality and reliability. Azeem (2020) confirms that New Zealand customers' acceptance of online banking is driven by quick service, security, reliability, and trust. These findings underscore the importance of customer-centric digital strategies in fostering satisfaction and loyalty.

2.5 Research Gap

Although extensive literature exists on online banking, customer satisfaction, and the effects of the COVID-19 pandemic (Gazi, 2024) and (Nautwima, 2022), a notable research gap remains. Indicative studies in New Zealand, such as (Aripin, 2023), focus broadly on digital banking adoption, but lack a specific examination of Kiwibank customers' experiences of online banking during the COVID-19 pandemic. There is limited empirical evidence addressing how service quality, usability, trust, and security influenced customer satisfaction in this specific institutional and crisis context. Therefore, this paper seeks to address this gap by providing empirical insights into Kiwibank customers' perceptions of online banking during the pandemic, contributing to both academic literature and practical banking strategies.

3. METHODOLOGY

3.1 Research Design

This paper adopts a descriptive research design (Dulock, 1993) to examine customer satisfaction with online banking services during the COVID-19 pandemic, with specific reference to Kiwibank customers in New Zealand. A descriptive design is appropriate as it enables systematic examination of customer perceptions, experiences, and evaluations of online banking usability and service quality without manipulating variables (Saunders et al., 2019). Similar research methods have been used in nursing research (Doyle et al, 2019) or real estate management studies (Rallang, 2024), whereby a step-by-step approach to the issue in question is explored, within predetermined parameters.

3.2 Research Philosophy and Approach

This is guided by an interpretivist research philosophy, which recognises that customer satisfaction is a subjective construct shaped by individual experiences and perceptions (Alharagsheh, 2020). Interpretivism allows for the incorporation of respondents' viewpoints and contextual understanding of online banking during a crisis period (Creswell, 2013). Consistent with the research objectives, a deductive approach is adopted to examine established concepts, such as service quality, trust, and usability, and assess their relevance to customer satisfaction in the pandemic context (Saunders et al., 2016).

3.3 Research Method

A quantitative research method is employed to capture measurable customer perceptions of online banking services. Quantitative methods are suitable for examining relationships between variables and for generating comparable results across respondents (Saunders et al., 2019). The use of a structured questionnaire, such as that developed by the researcher for this study, enables the collection of standardised data related to usability, satisfaction, trust, and service quality in online banking.

3.4 Data Sources and Sampling

Primary data were collected from Kiwibank customers in New Zealand, focusing on individuals aged between 24 and 55 years who actively use online banking

services. A non-probability convenience sampling technique (Stratton, 2023) was employed, allowing respondents to be selected based on accessibility and willingness to participate. This approach is commonly used in exploratory and context-specific studies where access to a complete sampling frame is limited. The final sample comprised 20 respondents, which was deemed adequate for achieving the exploratory objectives of the study within the constraints of time and access. In addition to primary data, secondary data, including Kiwibank annual reports and publicly available documents were consulted to support contextual analysis and interpretation.

3.5 Data Collection Procedure and analysis

Data were collected using a self-administered online questionnaire distributed via social media platforms, like LinkedIn and Facebook. Google Forms was used to design and administer the questionnaire due to its accessibility and ease of data management. Respondents were provided with consent forms to sign prior to participation, and completion of the questionnaire required approximately 10–15 minutes. Data collection was conducted over a two-week period. Collected data were analysed using descriptive statistical techniques, including frequency distributions and percentage analysis, to summarise respondents' perceptions of online banking usability and satisfaction. The analysis focused on identifying patterns and trends relevant to the study's objectives. The use of structured quantitative analysis supports clarity, comparability, and objective interpretation of findings (Saunders et al, 2016), all of which are crucial to keep a research ethically sound.

Ethical principles were strictly observed throughout the research process. Participation was voluntary, and respondents were assured of confidentiality and anonymity. Data was collected solely for academic purposes and securely stored with restricted access. Participants retained the right to withdraw from the study at any time without penalty. The research was conducted in accordance with institutional ethical guidelines and academic integrity standards.

4. RESEARCH FINDINGS AND DISCUSSION

This section presents and discusses the empirical findings derived from the analysis of primary data collected from 20 respondents who are customers of Kiwibank in New Zealand, with specific emphasis on customer perceptions with respect to experience, reliability, security, efficiency, trust, and satisfaction. The

analysis is aligned with the research objectives outlined earlier, with the primary data collected was analysed using SPSS, primarily through frequency analysis and descriptive statistics, complemented by qualitative content analysis (Saunders et al., 2019) of open-ended responses. The findings of this research are structured into two main sections: the first presents the research findings using frequency analysis, while the second provides a thematic discussion of these findings in relation to existing literature. This integrated approach enables a comprehensive understanding of both the quantitative trends and qualitative insights underlying customer perceptions of Kiwibank's online banking services during the pandemic.

4.2 Frequency Analysis of findings

4.2.1 Use of Net Banking During the COVID-19 Lockdown

The first question examined whether respondents used net banking during the 2021 COVID-19 lockdown in New Zealand. An overwhelming majority of participants (95%, n = 19) reported using net banking during lockdown, while only one respondent (5%) indicated that they rarely used internet banking during this period. These results clearly demonstrate that online banking became an essential service during the lockdown, largely due to the closure or limited accessibility of physical bank branches. One participant explicitly stated that net banking was used "to transfer money to the landlord", highlighting the practical necessity of digital financial services during movement restrictions. The near-universal adoption of net banking among respondents suggests that the dataset is well-suited to evaluating online banking usability and satisfaction during the pandemic, thereby strengthening the reliability of subsequent findings.

4.2.2 Customer Experience with Kiwibank Net Banking Services

Participants were asked to describe their experience using Kiwibank's net banking services. The results reveal an overwhelmingly positive experience among respondents. A large majority (80%, n = 16) reported having a "good" experience, while 10% (n = 2) described the service as "easy to use," and another 10% (n = 2) characterised it as "useful and convenient". Notably, none of the participants reported a negative experience. This suggests that Kiwibank's online banking platform was able to meet customer expectations during a period of heightened reliance on digital services. The findings indicate that usability, convenience, and overall functionality played a critical role in shaping positive customer experiences, particularly during the uncertainty and constraints

imposed by the pandemic. This conforms to existing literature which emphasises the usability of the technology and system functionality (Riyazahamed, 2019) as important determinants of customer satisfaction.

4.2.3 Perception of Kiwibank's Outlook and Visual Appeal

The study further examined respondents' perceptions of Kiwibank's appearance and visibility. About 90% of participants (n = 18) reported that they liked the appearance of Kiwibank, while only 10% (n = 2) expressed dissatisfaction. Participants who reported positive perceptions cited reasons such as a well-designed interface, bright colours, a comfortable visual layout, and an attractive logo. In contrast, one participant indicated dissatisfaction due to the red colour used in Kiwibank's branding. Overall, the findings suggest that Kiwibank's visual design and branding contribute positively to customer perception, although visual preferences remain subjective and vary among individuals. Thus, this finding extends the theories already established by Ling et al (2016) and Sakhaei et al (2014) that customer satisfaction is often influenced by visual appeal of the concerned technology.

4.2.4 Rating of Kiwibank Net Banking Services

Respondents were asked to rate Kiwibank's net banking services on a scale ranging from "neutral" to "very good". About 65% of participants (n = 13) rated the services as "good", while 25% (n = 5) rated them as "very good". Only 10% (n = 2) expressed a neutral opinion. Participants attributed their ratings to factors such as ease of use, faster transactions, clear navigation, ease of understanding, efficient fund transfers, and an overall user-friendly interface. Ease of usage emerged as the most frequently cited reason for higher ratings. These findings indicate a strong alignment between usability and customer satisfaction, reinforcing the importance of intuitive system design in online banking platforms, as already established by existing literature (Nayanajith et al, 2019).

4.2.5 Willingness to Recommend Kiwibank Net Banking Services

The willingness of customers to recommend a service is often regarded as a strong indicator of satisfaction and loyalty. About 60% of respondents (n = 12) stated that they would "very strongly" recommend Kiwibank's net banking services to friends and family, while 30% (n = 6) indicated they would recommend it as

"good". Only 10% (n = 2) remained neutral. Participants cited several reasons for their willingness to recommend the service, including trustworthiness, ease of use, suitability for elderly users, efficient software, proximity of the bank to residential areas, and appealing design features. These findings suggest that Kiwibank's net banking services not only meet functional needs but also foster positive word-of-mouth behaviour among customers. These constitute the very hinges on which customer loyalty (Sasono et al, 2021) is based.

4.3 Challenges Faced in Net Banking

Despite overall positive perceptions, participants identified several challenges associated with net banking. Common difficulties included remembering complex login credentials, repeatedly entering bank details during online shopping, and unfamiliarity with certain features such as saving beneficiary details. For example, one participant noted difficulty in saving transaction records for future use, while another highlighted inconvenience related to entering card details repeatedly for online purchases. These issues indicate that while online banking is largely effective, usability challenges - particularly for less technologically confident users, remain an important consideration for service improvement. This contradicts existing literature and shows that a working interface is not enough to be inclusive of all intended users. 'Usability' features of a product or service needs to be inclusive of its target market.

4.3.1 Reliability of Kiwibank Net Banking Services

Reliability emerged as a key theme in respondents' perceptions of Kiwibank's online banking services. About 90% of participants (n = 18) considered the services reliable, citing secure payment systems, confirmation prompts before transactions, and strong authentication processes. One participant emphasised that repeated confirmation of account details during fund transfers enhanced their confidence in the system. However, a small minority expressed reservations, with one respondent suggesting that Westpac's online banking services were more secure. Despite this isolated comparison, the overall perception of reliability was strongly positive and the responses were in support of existing literature.

4.3.2 Security Threats Experienced by Customers

Security concerns are a critical issue in online banking adoption (Seow, 2023). The findings indicate that security threats were minimal among respondents. About 85% of participants (n = 17) reported that they had never experienced a security threat while using Kiwibank's online services. Only one participant reported experiencing a security issue, while others expressed general concerns without direct experience. These findings suggest that Kiwibank's security mechanisms were effective during the pandemic period, contributing to customer trust and continued use of online banking services, as supported by existing literature.

4.3.3 Efficiency of Services and Trust in Online Transactions

Participants consistently described Kiwibank's online banking services as efficient, fast, and responsive. Several respondents highlighted the simplicity of transaction processes and the speed with which customer service addressed issues. Trust in online transactions was reinforced by strong verification procedures and responsive customer support, particularly when users encountered login or password issues. Overall, efficiency and trust were identified as closely linked determinants of customer satisfaction, reinforcing the role of service responsiveness and security in shaping positive user experiences. This affirms Azeem's (2020) claim that customer service in New Zealand constitutes a fine balance of efficient service and reliability.

5. THEMATIC DISCUSSIONS

The findings of this study align closely with existing literature on online banking adoption during the COVID-19 pandemic. Consistent with Marcu (2021), the results demonstrate that lockdowns significantly accelerated the use of digital banking services as physical branches became less accessible. Similar to Surendran and Acharya (2021), this study confirms that convenience, ease of use, and efficiency are central to positive customer experiences with online banking. The positive ratings and high recommendation levels observed in this study support the argument that service quality dimensions, such as reliability, security, and usability, directly influence customer satisfaction and loyalty (Amin, 2016; Ling et al., 2021). While minor usability challenges were reported, these did not significantly undermine overall satisfaction, suggesting that customers were willing to tolerate small inconveniences in exchange for safety, accessibility, and convenience during the pandemic.

The findings highlight that trust and reliability play a particularly important role in crisis contexts, where customers rely heavily on digital platforms for essential financial transactions. This supports prior research by Safi and Awan (2018), which emphasises the importance of trust-building mechanisms in online banking adoption. Thus, the findings reveal that Kiwibank's online banking services were widely used, positively perceived, and trusted by customers during the COVID-19 pandemic. High levels of satisfaction, strong perceptions of reliability and security, and a willingness to recommend the service indicate that online banking played a critical role in maintaining financial continuity during the lockdown period. While some usability challenges remain, the overall evidence suggests that Kiwibank's net banking services effectively met customer needs and contributed to positive banking experiences during an unprecedented global crisis.

6. CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS

This section synthesises the findings of the study and provides a comprehensive reflection on the research objectives, key empirical insights, and their implications for online banking practices during crisis situations. It begins with an integrated conclusion that revisits the research aim, questions, and objectives, and consolidates the main findings related to customer satisfaction and perceived usability of Kiwibank's online banking services during the COVID-19 pandemic. This is followed by a set of practical and strategic recommendations directed at Kiwibank management and relevant stakeholders. Finally, it outlines the limitations of the study and identifies directions for future research to extend and refine understanding of online banking adoption and customer satisfaction in both crisis and post-crisis contexts.

The COVID-19 pandemic created unprecedented challenges for the global banking sector, forcing rapid digital transformation and heightened reliance on online service delivery. In this context, understanding customer perceptions, trust, satisfaction, and usability of online banking platforms became critically important. By focusing on Kiwibank customers in New Zealand, this study contributes to the growing body of knowledge on digital banking adaptability, customer-centric service delivery, and technology adoption during periods of systemic disruption.

6.1 Conclusions

The central aim of this study was to examine customer satisfaction with Kiwibank's online banking services during the COVID-19 pandemic, with

particular emphasis on perceived usability, reliability, security, efficiency, and trust. The research was motivated by the broader disruption caused by the pandemic and the reputational and operational challenges faced by Kiwibank following cybersecurity incidents such as Distributed Denial of Service (DDoS) attacks. In this context, assessing customer perceptions of online banking usability and service quality was both timely and significant.

6.1.1 Robust Infrastructure to meet Customer Needs

The findings of the study demonstrate that the COVID-19 pandemic significantly accelerated the adoption and reliance on online banking services among Kiwibank customers. Despite the closure or restricted operation of physical bank branches, online banking enabled customers to maintain continuity in essential financial activities such as fund transfers, bill payments, balance inquiries, and account management. As a result, online banking emerged not merely as a supplementary service but as a core banking channel during the pandemic. The data conclusively establishes that customer satisfaction with Kiwibank's online banking services during the pandemic was generally high. Most participants reported positive experiences, favourable perceptions of usability, strong trust in online transactions, and confidence in the reliability and security of the platform. These findings suggest that Kiwibank's online banking infrastructure was sufficiently robust to meet customer needs during a period of heightened demand and uncertainty.

6.1.2 Customer Satisfaction and Experience During the Pandemic

One of the most significant conclusions of this study is that the pandemic, despite its disruptive nature, contributed positively to the acceptance and normalisation of online banking services. The forced shift away from physical banking accelerated digital adoption and reshaped customer expectations. Customers who may have previously relied on branch-based services became more comfortable with digital platforms and developed greater trust in online banking systems.

The findings indicate that Kiwibank successfully managed this transition by providing services that were perceived as efficient, reliable, and secure. High levels of trust in online transactions were attributed to features such as multi-step verification, confirmation prompts, strong authentication mechanisms, and responsive customer service. These features reassured customers and reduced perceived risk, which is a critical factor in online banking adoption. The willingness of customers to recommend Kiwibank's online banking services to

friends and family reflects not only satisfaction but also emerging customer loyalty. Recommendation behaviour suggests that customers viewed the service as dependable and beneficial, even in comparison with competing banks. This is particularly noteworthy given the heightened sensitivity to cybersecurity risks during the pandemic.

6.1.3 Theoretical Contributions

From a theoretical perspective, this study contributes to the literature on online banking, customer satisfaction, and crisis-driven digital transformation. The findings support existing theories such as the TAM and electronic service quality frameworks (Seow, 2003) by reaffirming the importance of perceived usefulness, ease of use, reliability, and security in shaping user attitudes and satisfaction. The study extends these theories into a crisis context, demonstrating that the same determinants of satisfaction remain relevant during periods of systemic disruption, albeit with heightened emphasis on security, trust, and reliability. The pandemic context amplified customer sensitivity to service failures and cybersecurity risks, making trust-related factors particularly salient. This insight adds depth to existing models by highlighting the dynamic nature of customer expectations under crisis conditions.

6.1.4 Achievement of Research Objectives

The first research objective sought to evaluate customer perceptions of online banking usability during the COVID-19 pandemic. The findings clearly indicate that Kiwibank's online banking services were perceived as user-friendly, convenient, and accessible. A substantial proportion of respondents described their experience as "good", "easy to use", and "useful and convenient". These perceptions were reinforced by positive evaluations of system navigation, transaction speed, and clarity of processes. The results suggest that usability played a critical role in shaping overall customer satisfaction, particularly during a period when customers had limited alternatives to digital banking.

The second research objective aimed to identify the determinants that improve customer satisfaction with Kiwibank's online banking services during the pandemic. The findings reveal that customer satisfaction was influenced by a combination of functional and psychological factors. Key determinants included ease of use, efficiency of services, reliability of transactions, perceived security, trust in the system, and responsiveness of customer support. While minor challenges such as password complexity and repetitive data entry were reported,

these did not significantly undermine satisfaction levels, indicating that customers were willing to tolerate certain inconveniences in exchange for secure and efficient service delivery.

The third research objective examined whether the quality of online banking services affected customer satisfaction during the pandemic. The study provides strong evidence of a positive relationship between service quality dimensions, such as reliability, security, efficiency, and trust, and customer satisfaction. Participants who perceived Kiwibank's online services as reliable and secure were more likely to rate the services positively and recommend them to others. This confirms that service quality remains a critical driver of satisfaction even in crisis contexts, reinforcing established theories of electronic service quality and technology acceptance.

6.2 Recommendations

Based on the empirical findings and conclusions of the study, several practical and strategic recommendations are proposed for Kiwibank and relevant stakeholders. These recommendations are intended to enhance customer satisfaction, strengthen trust, and improve the overall effectiveness of online banking services in both crisis and normal operating conditions.

6.2.1 Enhancing Digital Literacy and Customer Education

Although the findings indicate high overall satisfaction, some participants reported difficulties related to password management, account navigation, and repeated data entry. These challenges were particularly evident among users who may be less technologically confident. It is, therefore, recommended that Kiwibank introduce comprehensive digital education initiatives aimed at improving customer familiarity with online banking features. Short instructional videos, interactive tutorials, and step-by-step guides - available in both video and audio formats - could be integrated into the online banking platform and mobile application. These resources should be designed to cater to diverse customer segments, including elderly users and first-time digital banking adopters. Such initiatives would not only reduce usability challenges but also empower customers to use advanced features more effectively, thereby enhancing satisfaction and reducing reliance on customer support services.

6.2.2 Strengthening Cybersecurity Awareness and Trust

Despite minimal reported security threats, customer perceptions of security remain a critical determinant of satisfaction and trust. Given the increasing sophistication of cybercrime and online scams, proactive communication is essential to maintain customer confidence. Kiwibank should implement ongoing cybersecurity awareness campaigns using multiple communication channels, including SMS alerts, emails, social media platforms, and in-app notifications. These campaigns should educate customers about common scams, phishing attempts, and safe online banking practices. Clear guidance should be provided regarding the types of information that should never be shared, even with individuals claiming to represent the bank. By positioning itself as a proactive partner in customer security, Kiwibank can further strengthen trust and reduce perceived risk associated with online banking.

6.2.3 Investment in Advanced and Resilient IT Infrastructure

The study highlights the importance of system reliability and efficiency in shaping customer satisfaction. To maintain and enhance these attributes, it is recommended that Kiwibank continue investing in advanced IT infrastructure, including secure cloud-based systems (Seow, 20023) and enhanced cybersecurity frameworks (Seow, 2003). Migration to secure cloud environments can improve system resilience, scalability, and disaster recovery capabilities while reducing the risk of service disruptions caused by cyberattacks or sudden increases in demand (Panditharathna, 2024). Such investments are particularly important in light of past cybersecurity incidents and the growing dependence on digital banking channels, such as the CapitalOne breach in 2019 (Neto, 2020).

6.2.4 Implementing Robust Customer Feedback Mechanisms

Customer satisfaction is dynamic and influenced by evolving expectations and technological advancements (Sasono, 2021). To remain responsive, Kiwibank should strengthen its customer feedback mechanisms by actively collecting and analysing feedback through online surveys, social media interactions, and in-app rating systems. Real-time feedback tools would enable the bank to identify emerging issues, address service gaps promptly, and continuously refine its online banking offerings. Transparent communication about how customer feedback is used to improve services can further enhance trust and customer engagement.

6.3 Limitations and Future Research

While this research provides valuable insights into customer satisfaction with Kiwibank's online banking services during the pandemic, several limitations must be acknowledged. Firstly, the study relied on a relatively small sample size of 20 participants. Although sufficient for exploratory analysis, this limits the generalisability of the findings to the broader population of Kiwibank customers. Secondly, the study primarily employed a quantitative survey approach with limited qualitative depth. While open-ended responses provided useful contextual insights, in-depth interviews could have yielded richer and more nuanced understanding of customer experiences and perceptions. Finally, the study focused exclusively on customers and did not incorporate perspectives from Kiwibank employees or management. Including organisational viewpoints could have provided a more holistic understanding of service delivery challenges and strategic responses during the pandemic.

The pandemic did not merely accelerate digital banking adoption; it fundamentally reshaped customer expectations around accessibility, responsiveness, security, and seamless user experience. As hybrid service ecosystems become the norm, institutions such as Kiwibank must move beyond emergency digitalisation toward intentional digital transformation, that integrates technological innovation with relational trust-building. In the post-pandemic environment, as systemic shocks become more frequent and technology adoption accelerates, research such as this remains highly relevant for informing future-ready service models and strengthening the sector's capacity to respond effectively to uncertainty.

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