UNIVERSITAT POLITÈCNICA DE VALÈNCIA

**DOCTORAL THESIS**

# PROVIDING A MODEL FOR ESTIMATING THE SUCCESS OF ELECTRONIC CUSTOMER RELATIONSHIP MANAGEMENT (ECRM) SYSTEMS IN INDUSTRY MANAGEMENT


Presented by:
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**Valencia, September 2024**

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Center for Physical Technologies
Department of Applied Physics
School of Aerospace Engineering and Industrial Design

## Resumen

**Propósito -** en el competitivo mercado global actual, las empresas deben priorizar los servicios orientados al cliente y proporcionar productos accesibles, innovadores y de alta calidad para satisfacer las necesidades de los clientes. Las instituciones técnicas, deservicios y educativas deben garantizar la más alta calidad de servicios para tener éxito en la era de la tecnología. La satisfacción del cliente es crucial para su lealtad y el logro de los objetivos de la empresa, como la generación de ingresos, la mejora de la calidad de vida y el aumento de la productividad. Sin embargo, la implementación de proyectos costosos y que requiere mucho tiempo, puede obstaculizar estos esfuerzos. La gestión electrónica de relaciones con los clientes (ECRM)* es una solución para abordar estos desafíos centrándose en el comportamiento del cliente, la gestión del cambio y la innovación, la gestión del ciclo de productos y servicios, la gestión de la cadena de suministro y la gestión de procesos comerciales. La implementación efectiva de ECRM puede ayudar a reducir el tiempo y los costos de implementación del proyecto y, en última instancia, aumentar la satisfacción y lealtad del cliente.

**Diseño/metodología/enfoque -** Se ha utilizado el Modelado de Ecuaciones Estructurales para analizar el modelo propuesto. También se ha definido un modelo conceptual para la categorización, análisis y evaluación de los resultados y datos recogidos por el software SmartPLS 4.0.8.2. Para recopilar datos se encuestó a un total de 385 participantes-

Hallazgos: Los hallazgos demuestran que todos los factores tomados en cuenta, a saber, la innovación tecnológica, la gestión de la cadena de suministro, la gestión empresarial, la gestión estratégica y el desarrollo de la producción, contribuyen significativamente al éxito de ECRM en proyectos industriales. La evaluación y verificación, confiabilidad y validez se realizaron mediante el modelo de ecuaciones estructurales.

**Limitaciones/implicaciones de la investigación -** en primer lugar, hay escasez de investigaciones sobre las relaciones entre la innovación tecnológica, el desarrollo de la producción, la ECRM, la gestión estratégica, la gestión de la cadena de suministro y la gestión empresarial en universidades extranjeras. En segundo lugar, la muestra estadística puede no ser generalizable a toda la población y a todas las situaciones. En tercer lugar, las limitaciones de tiempo y factores como la burocracia organizacional dificultaron la recopilación de información del personal del proyecto. En cuarto lugar, debido a la falta de documentos escritos y la falta de uniformidad de los procesos de los proyectos, resulta difícil estimar los costos indirectos. Finalmente, el modelo fue diseñado e implementado para un proyecto muestra en la industria petrolera y el sector transporte. Se debe tener precaución al generalizarlo a otras industrias y proyectos relacionados.

**Originalidad/valor -** la metodología sugerida proporciona una comprensión integral de los diversos factores externos que influyen en el éxito del desarrollo de proyectos industriales a través del reconocimiento de la Gestión Electrónica de las Relaciones con los Clientes. Este

estudio apoyará directamente a académicos y profesionales laborales para que conozcan mejor el progreso de la gestión de la industria.

**Palabras clave -** Innovación Tecnológica, Gestión de la Cadena de Suministro, Gestión Empresarial, Gestión Estratégica, Desarrollo de la Producción, Gestión Electrónica de las Relaciones con los Clientes.

*En inglés: Electronic Customer Relationship Management (ECRM)

Structural Equation Modeling (SEM)

## Resum

**Propòsit -** en el competitiu mercat global actual, les empreses han de prioritzar els servicis orientats al client i proporcionar productes accessibles, innovadors i d'alta qualitat per a satisfer les necessitats dels clients. Les institucions tècniques, *deservicios i educatives han de garantir la més alta qualitat de servicis per a tindre èxit en l'era de la tecnologia. La satisfacció del client és crucial per a la seua lleialtat i l'assoliment dels objectius de l'empresa, com la generació d'ingressos, la millora de la qualitat de vida i l'augment de la productivitat. No obstant això, la implementació de projectes costosos i que requerix molt temps, pot obstaculitzar estos esforços. La gestió electrònica de relacions amb els clients (*ECRM)* és una solució per a abordar estos desafiaments centrant-se en el comportament del client, la gestió del canvi i la innovació, la gestió del cicle de productes i servicis, la gestió de la cadena de subministrament i la gestió de processos comercials. La implementació efectiva de *ECRM pot ajudar a reduir el temps i els costos d'implementació del projecte i, en última instància, augmentar la satisfacció i lleialtat del client.

**Dissenye/metodologia/enfoque -** S'ha utilitzat el Modelatge d'Equacions Estructurals per a analitzar el model proposat. També s'ha definit un model conceptual per a la categorització, anàlisi i avaluació dels resultats i dades arreplegades pel programari *SmartPLS 4.0.8.2. Per a recopilar dades es va enquestar a un total de 385 participants-

Troballes: Les troballes demostren que tots els factors tinguts en compte, a saber, la innovació tecnològica, la gestió de la cadena de subministrament, la gestió empresarial, la gestió estratègica i el desenvolupament de la producció, contribuïxen significativament a l'èxit de *ECRM en projectes industrials. L'avaluació i verificació, confiabilitat i validesa es van realitzar mitjançant el model d'equacions estructurals.

**Limitacions/implicacions de la investigació -** en primer lloc, hi ha escassetat d'investigacions sobre les relacions entre la innovació tecnològica, el desenvolupament de la producció, la *ECRM, la gestió estratègica, la gestió de la cadena de subministrament i la gestió empresarial en universitats estrangeres. En segon lloc, la mostra estadística pot no ser generalitzable a tota la població i a totes les situacions. En tercer lloc, les limitacions de temps i factors com la burocràcia organitzacional van dificultar la recopilació d'informació del personal del projecte. En quart lloc, a causa de la falta de documents escrits i la falta d'uniformitat dels processos

dels projectes, resulta difícil estimar els costos indirectes. Finalment, el model va ser dissenyat i implementat per a un projecte mostra en la indústria petroliera i el sector transporte. S'ha de tindre precaució en generalitzar-ho a altres indústries i projectes relacionats.

**Originalitat/valor -** la metodologia suggerida proporciona una comprensió integral dels diversos factors externs que influïxen en l'èxit del desenvolupament de projectes industrials a través del reconeixement de la Gestió Electrònica de les Relacions amb els Clients. Este estudi farà costat directament a acadèmics i professionals laborals perquè coneguen millor el progrés de la gestió de la indústria.

**Paraules clau -** Innovació tecnològica, Gestió de la cadena de subministrament, Gestió empresarial, Gestió estratègica, Desenvolupament de la producció, Gestió electrònica de les relacions amb els clients.

*En anglés: Electronic Customer Relationship Management (ECRM)

Structural Equation Modeling (SEM)

## Summary

**Purpose -** In today's competitive global market, companies must prioritize customer-oriented services and provide high-quality, innovative, accessible products to meet customer needs. Service and technical institutions and educational institutions must ensure the highest quality of services to succeed in the technology era. Customer satisfaction is crucial for customer loyalty and achieving company goals, such as income generation, quality of life improvement, and productivity increase. However, time-consuming and costly project implementation can hinder these efforts. Electronic Customer Relationship Management (ECRM) is a solution to address these challenges by focusing on customer behavior, change and innovation management, product and service cycle management, supply chain management, and business process management. Effective ECRM implementation can help reduce project implementation time and costs, ultimately increasing customer satisfaction and loyalty.

**Design/methodology/approach -** Structural Equation Modeling (SEM) has been used to analyze the proposed model. A conceptual model has also been defined so that the results and data collected by SmartPLS software 4.0.8.2 have been categorized, analyzed, and evaluated from questionnaires. A total of 385 participants, who were employees of two major industrial projects, were surveyed to gather the data.

**Findings -** The findings demonstrate that every factor taken into account, namely Technological Innovation, Supply Chain Management, Business Management, Strategic Management, and Production Development, significantly contributes to the success of ECRM in industrial projects. The assessment and verification, reliability, and validity were carried out using the structural equation model.

**Research limitations/implications -** Firstly, there is a scarcity of research on the relationships between Technological Innovation, Production Development, ECRM, Strategic Management, Supply Chain Management, and Business Management in foreign universities. Secondly, the statistical sample may not be generalizable to the entire population and all situations. Thirdly, time constraints and factors such as organizational bureaucracy made gathering information from project personnel difficult. Fourthly, due to the lack of written documents and non-uniformity of project processes, it is challenging to estimate indirect costs. Lastly, the model

was designed and implemented for a sample project in the oil industry and the transport sector. Caution should be taken when generalizing it to other related industries and projects. **Originality/value -** The suggested methodology provides a comprehensive understanding of the various external factors that influence the success of industrial project development through the recognition of Electronic Customer Relationship Management. This study will directly support academics and job professionals in better knowledge of the industry's management progress.

**Keywords:** Technological Innovation, Supply Chain Management, Business Management, Strategic management, Production development, Electronic Customer Relationship Management

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Finally, I thank all my friends, even the ones I lost contact with them.

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## Acronyms and Definitions

Table 1- Acronyms and Definitions

| | |
|---|---|
| **AI** | Artificial Intelligence |
| **AVE** | Average Variance Extracted |
| **BPSD** | Barrels Per Stream Day |
| **CB-SEM** | Covariance-Based Structural Equation Modeling |
| **CFA** | Confirmatory Factor Analysis |
| **CR** | Construct Reliability |
| **CRM** | Customer Relationship Management |
| **ECRM** | Electronic Customer Relationship Management |
| **EFA** | Exploratory Factor Analysis |
| **EPC** | Engineering Procurement Construction |
| **ERP** | Enterprise Resource Planning |
| **ESEM** | Exploratory Structural Equation Modeling |
| **FA** | Factor Analysis |
| **GoF** | Goodness of Fit |
| **GFI** | Goodness of Fit Index |
| **GSCA** | Generalized Structural Component Analysis |
| **HSE** | Health Safety Executive |
| **HTMT** | Heterotrait-Monotrait ratio of correlation |
| **HVAC** | Heating, Ventilation, and Air Conditioning |
| **I&C** | Instrument and Control |
| **IoT** | Internet of Things |
| **IS** | Information System |
| **IT** | Information Technology |
| **MA** | Multivariate Analysis |
| **NEUSREL** | Nonlinear Universal Structural Relational Modeling |
| **NFI** | Normed Fit Index |
| **OEM** | Original Equipment Manufacturer |
| **PEM** | Partial Equation Modeling |
| **PLS** | Partial Least Squares |
| **PMS** | Project Management System |
| **QS** | Quality Service |
| **R&D** | Research and Development |
| **ROI** | Return On Investment |
| **RM** | Relationship Marketing |
| **RMS** | Root Mean Square |
| **SCI** | Supply Chain Integration |
| **SCM** | Supply Chain Management |
| **SEM** | Structural Equation Modeling |
| **SRMR** | Standardized Root Mean square Residual |
| **SSE** | Sum of the Squared prediction Errors |

| | |
|---|---|
| **SSO** | Sum of the Squared Observations |
| **STDEV** | Standard Deviation |
| **VAF** | Variance Accounted For |
| **VIF** | Variance Inflation Factor |
| **WBS** | Work Breakdown Structure |

# Chapter 1
# Introduction

## 1.1. BACKGROUND

The first computer that stored customer information was formed in the '80s and the late '90s. Customer-oriented software began to operate widely, and the birth of modern and advanced customer-oriented software was formed in the '90s. Some attribute it to Thomas Siebel (1993), the founder of Siebel Systems, and others credit it to Bradway and Purchia (2000), who expanded modern Electronic Customer Relationship Management (ECRM) functions by using the Internet.

At the end of 1999, there was a revolution in Customer Relationship Management; its online infrastructure started, and in the 2000s, due to the increase in its quality, this management became integrated. In the mid-2000s, automation and marketing started working as part of customer management. Customer Relationship Management (CRM) networks reached their peak in the 2010s. Due to the existence of social networking platforms, these online networks formed a new form of communication.

In recent years, the term "Customer Relationship Management" (CRM) has attracted much attention in various fields of technology, information, project excellence, etc. The concept of CRM means the effort of organizations, companies, and enterprises to create and provide higher value to the customer. Organizations have widely recognized that customers in the market, industrial, and knowledge-demanding projects are their most important assets, and they consider relationships with customers as opportunities for organizations to excel (Richards & Jones, 2008).

Improving communication quality via information technology is essential for enhancing service and production quality in a customer-centric approach. This leads to increased satisfaction, loyalty, and efficiency. The development of the Internet has turned the world into small villages. The Internet is considered a suitable platform for conducting many industrial and commercial exchanges, and employers and customers in the virtual world have different needs that cannot be met in traditional ways.

Establishing closer and deeper relationships with customers and the necessary flexibility to change the behavior of companies in relation to the interests and needs of each customer can facilitate the design and implementation of Electronic Customer Relationship Management (ECRM) and, as a result, profitability.

Electronic Customer Relationship Management is an integrated marketing, sales, and electronic service strategy that plays a role in identifying, acquiring, and maintaining customers who are the company's greatest asset (Peelen & Beltman, 2014).

One of the fundamental modifications in business beliefs is a change in the approach of organizations from mass and general relations with different groups of customers to individual and virtual relations with them through information and communication technology; in other words, it is a business strategy that aims to increase volume. In order to continue better business transactions in a company and electronic management of customer relations, the result is the use of web and Internet technology to facilitate, implement, and make CRM systems more efficient (Keramati & Mehrabi, 2010).

The internet has disrupted traditional business models, forcing companies to adapt and creating new opportunities for innovation and growth. The trend towards digital tools and platforms is intensifying global competition and changing how businesses operate, with products and activities increasingly moving online and customer interactions taking place online. Internal tools will provide these facilities when they are properly integrated with these items and properly customized.

In a professional project and dynamic business environment, the main priority of those organizations is to improve services and strengthen business relations with society, people, employers, and internationally. The technique of maintaining customer relations under the title of customer-oriented relationship management helps companies maintain and improve customer relations through electronic customer relationship management. Collecting and analyzing customer information and data helps organizations communicate with customers in different ways and minimize their costs and access (Coltman et al., 2011).

As an accessible and fast technology-oriented communication, ECRM can update traditional customer-oriented techniques with innovative technologies and define their relationships with customers through software, the Internet, and applications. Innovative Internet-based technologies allow organizations to attract new customers analyze their behaviors, tastes, and needs, and order specific, accessible, fast, and user-friendly support programs and manage them. Strategies promote and maintain customer loyalty and thereby help the organization become better known by recommending customers to each other in the market (Popovich & Chen, 2003).

In today's digital age, the content of CRM and ECRM are the same and differ only in the way they are implemented. In this way, in ECRM, more attention is paid to the relationship between customers and organizations, more efficiency of the system, relationships between companies, the direct relationship between the product and the organization, and their celebration and improvement through technology and Internet connections, e-mail, and chain management. Fast supply chain management, agile project management, long-term relationships with customers and the market, innovative strategic management, accessible advanced technologies, etc. (Payne & Frow, 2006).

Customer loyalty has a positive relationship with customer satisfaction because satisfied customers regularly prefer brands, services, and products that meet their needs. Brand loyalty stems from companies' efforts to create consistency in providing quality products without change. The emergence of a sense of loyalty in customers can be caused by many reasons, such as product, services, brand, distribution, price and relationships. Repeated purchases of the same product can be due to product features or quality. Customer loyalty to a brand usually results from reputation and customer experience. Customers are usually loyal to all products offered by a brand or its subset. Customers may be loyal to a particular location simply because it is convenient and accessible. A customer may be loyal to someone, such as a salesperson, rather than the product, service, or brand (Karakostas et al., 2005).

ECRM is a strategy that integrates marketing, sales, and electronic service to manage customer relationships effectively. It involves using digital tools and platforms to collect and analyze customer data, personalize customer experiences, and improve customer satisfaction. According to the article, ECRM has become increasingly important in today's digital age, as customers expect personalized and seamless experiences across all channels and touchpoints. The article also highlights the benefits of ECRM for businesses, including improved customer loyalty, increased sales, and enhanced brand reputation. By leveraging customer data and insights, businesses can tailor their offerings to meet individual customers' specific needs and preferences, leading to higher customer satisfaction and retention. Moreover, ECRM can help businesses streamline operations, reduce costs, and improve their performance. However, the article notes that implementing ECRM requires a strategic approach, including clear goals, effective communication, and ongoing evaluation and improvement (Magatef et al., 2023).

## 1.2. MOTIVATION AND PROBLEM STATEMENT

A better understanding of which factors affect the success of companies and organizations is effective in how managers decide to invest in information technology (IT) and information systems (IS). In companies and organizations, it should be determined what the strategic goals of the companies are regarding the adoption of ECRM, how much the net income and benefits will be, and what the main effective and critical factors in the success of the company's ECRM in industrial markets and inter-industry management (Hendricks et al., 2007).

Strong strategic management guarantees all business processes because all information works in an organized and secure manner. An efficient ECRM system automates management tasks, equipment supply activities, and input data for improved efficiency, accuracy, and decision-making. This integration enhances customer experiences, increases loyalty, and drives business growth. All activities of companies and organizations, including all incoming raw materials, all processing and manufacturing processes, all output processes, all intelligent marketing networks, and modern customer-oriented management, are carried out automatically (Azar et al., 2012).

An innovative ECRM system, along with other systems such as Supply Chain management (SCM), Enterprise Resource Planning (ERP), Original Equipment Manufacturer (OEM), Quality Service (QS), and Project Management System (PMS), can automatically integrate and accept all data information according to the company's goals. For companies and organizations to make better investments, companies must know the main drivers well. To carry out the necessary strategies in the field of advanced customer relationship management, an organization must examine various motivations, which have many complexities (Hair, Hult, Ringle, & Sarstedt, 2016).

Customer relationship management is a strategic necessity in all organizations, the effective implementation of which can increase customer satisfaction and loyalty and result in more sales and repeat purchases. However, the implementation of CRM is not always accompanied by the expected results because the attitude of many organizations toward customer relationship management is from the point of view of technology. This wrong attitude towards this issue has caused its implementation to fail in many organizations. Therefore, company managers pay special attention to CRM because this tool can help those companies

in a successful way. Therefore, determining the relationship between the quality of the work process and customer relationship management is very important and can provide the effectiveness and efficiency of organizations.

The Main motivations of organizations and companies, according to the literature, are:

- To better analyze and understand the needs of customers to create and maintain relationships, customer loyalty, and repeat purchases, it is necessary to increase the organization's knowledge about customers.
- The needs and suggestions of customers should be heard so that the necessary predictions can be made in the future to meet their new demands and provide value-added services.
- Providing new products, superior, and distinctive customized services from their competitors.
- To create a simple, efficient, and user-friendly communication channel for current and permanent customers of the organization.
- To increase motivation and create effectiveness for sellers and agents in increasing sales and reducing costs.
- To Improve the company's information and data technologies, improve the organization's decision-making process, and improve internal strategies.
- Rationalizing current product production and gathering customer information to promote new products, managing supply chain and demand flow to reduce purchasing time, and responding and improving after-sales service.

The main problems are:

- Problems related to identifying the market and designing products according to customer needs due to the lack of a comprehensive database.
- Lack of expert forces for proper risk assessment.
- Lack of necessary cooperation and coordination between universities and higher education institutions with companies.

The main challenge is:

- The traditional and inappropriate structure in companies does not match with the company's structure and, in many cases, has deprived the companies of flexibility and mobility according to the environmental conditions (Reinartz et al., 2009).

## 1.3. RESEARCH HYPOTHESES, MODEL AND OBJECTIVES

Electronic Customer Relationship Management (ECRM) is not a solution to a problem but a strategy, and if it is implemented in an environment (company and workshop) as a partnership and cooperation, it can be considered a huge competitive advantage.

Research Hypotheses:

H1. Technological Innovation has a strong effect on ECRM.

H2. Technological Innovation has a strong effect on Supply Chain Management.

H3. Supply Chain Management has a strong effect on ECRM.

H4. Technological Innovation has a strong effect on Business Management.

H5. Business Management has a strong effect on ECRM.

H6. Supply Chain Management mediates the effect of Technological Innovation on ECRM.

H7. Business Management mediates the effect of Technological Innovation on ECRM.

H8. Production development mediates the effect of Technological Innovation on ECRM.

H9. Strategic management moderates the effect of Technological Innovation on ECRM.

Structural Equation Modeling (SEM):

SEM has been used to analyze the proposed model. A conceptual model has also been defined for the purpose that the results and data collected by SmartPLS version 4.0.8.2 have been categorized, analyzed, and evaluated. For this purpose, 385 respondents with an acceptance rate of 95% were sampled as witnesses.

Structural Model:

The Structural Model and Hypotheses are tested by using Partial Least Squares (PLS) (the $R^2$ values, the T-value, and the Goodness of fit (GoF) index).

The following conceptual model shown in Figure 1 is used to test the relationships between the nine (9) hypotheses considered in this study:

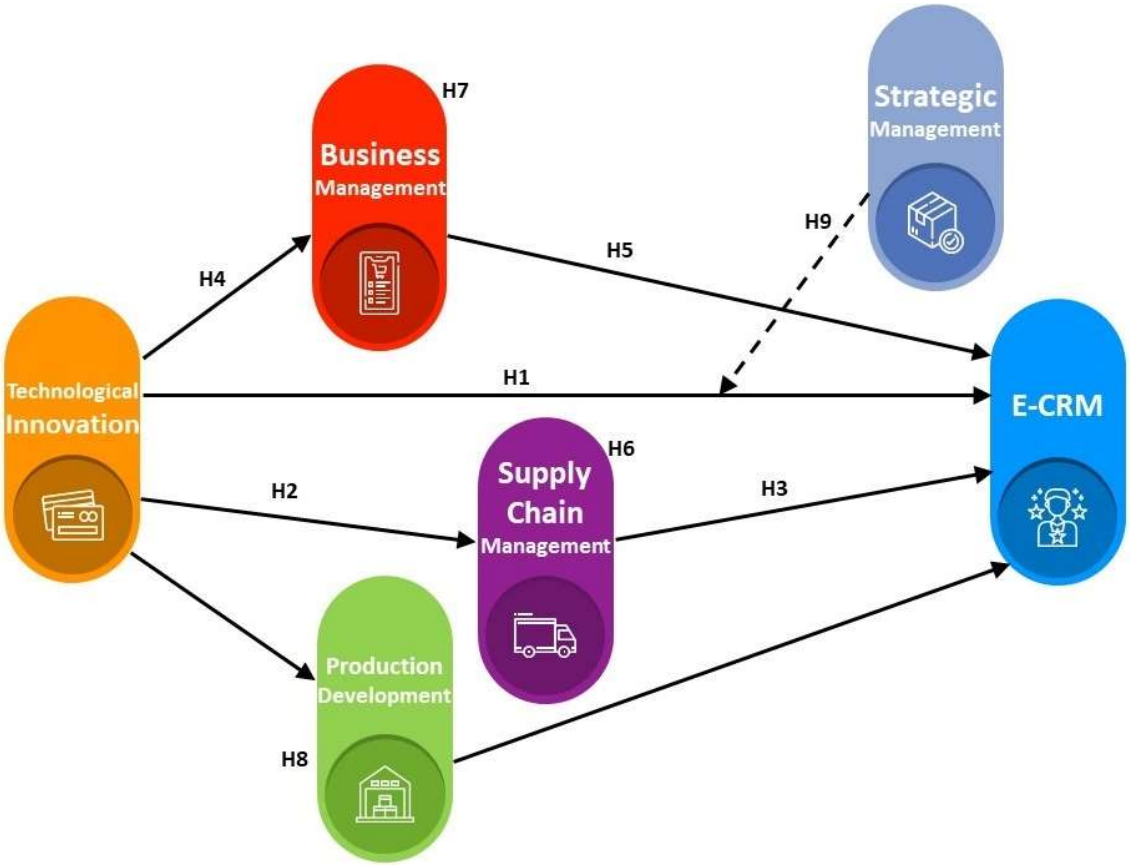



Figure 1- Conceptual Model for EPC Project
Source: Author's own

Providing a model for estimating the success of the Electronic Customer Relationship Management (ECRM) system is a goal for helping the academic and technical community to have a better understanding of the main motivations of the company to implement the ECRM system and to better identify the potential needs of customers.

Object 1: Assess the impact of technological innovation on Electronic Customer Relationship Management (ECRM) systems and Supply Chain Management (SCM) processes.

- To evaluate the degree to which technological innovation affects the implementation and effectiveness of ECRM systems.
- To investigate the influence of technological innovation on SCM processes and performance.
- To explore the mediating effect of SCM on the relationship between technological innovation and ECRM and to identify specific SCM practices that enhance this effect.

- To analyze the mediating role of business management in the relationship between technological innovation and ECRM and to identify specific management strategies that strengthen this effect.
- To investigate the extent to which production development mediates the relationship between technological innovation and ECRM and identify key production processes contributing to this effect.

Object 2: Examine the role of business management in facilitating the adoption and optimization of ECRM systems and practices.

Specific objectives:

- To investigate the relationship between technological innovation and business management strategies and their combined impact on organizational outcomes.
- To examine the role of business management in facilitating the adoption and optimization of ECRM systems and practices.
- To assess the moderating effect of strategic management on the relationship between technological innovation and ECRM and to determine how strategic orientation and decision-making influence the adoption and success of ECRM initiatives.

Object 3: Identify specific SCM practices, management strategies, and production processes that contribute to the success of ECRM initiatives.

Specific objectives:

- To determine the degree to which SCM practices affect the success of ECRM initiatives.
- To identify specific SCM practices that enhance the mediating effect of SCM on the relationship between technological innovation and ECRM.
- To identify specific management strategies that strengthen the mediating role of business management in the relationship between technological innovation and ECRM.
- To identify key production processes that contribute to the mediating effect of production development on the relationship between technological innovation and ECRM.

These objectives aim to provide a comprehensive understanding of the interplay between technological innovation, supply chain management, business management, production development, strategic management, and ECRM, and to offer insights into how organizations can optimize their ECRM systems and strategies for improved performance and customer satisfaction.

In this study, samples of different projects that have been implemented or are being implemented in the last eight years have been used. Large national industrial projects that have been launched with different goals or are still being built, installed, and implemented. These two projects are as follows, from the last to the first:

1. Project in the Oil industry
2. Project in the Transport sector

The accessible information based on the above-mentioned projects is based on the information that I have directly participated in those projects, and I have been part of the engineering team of those projects in the last 8 years, so this information is as follows:

1. Direct access to information and details of projects and direct communication with all managers and engineers of technical and design offices and engineers working in workshops and sites.
2. Simultaneous research with the execution and engineering of projects, access to information and details of all projects, especially the information of employers, contractors, and customers directly and by coordination and management tools and software.
3. Direct communication with the elements of business, organizational management, market development, and customer affairs of projects
4. The similarity of the projects mentioned above: in all projects, basic studies, finance, research and development, organizational, customer relations, supply chains, management and application strategies, organizational guidelines, and communication affairs have been carried out, and these studies have been developed and include research details.

## 1.4. METHODOLOGY

The summary of the methodological parts of the study objectives is as follows:

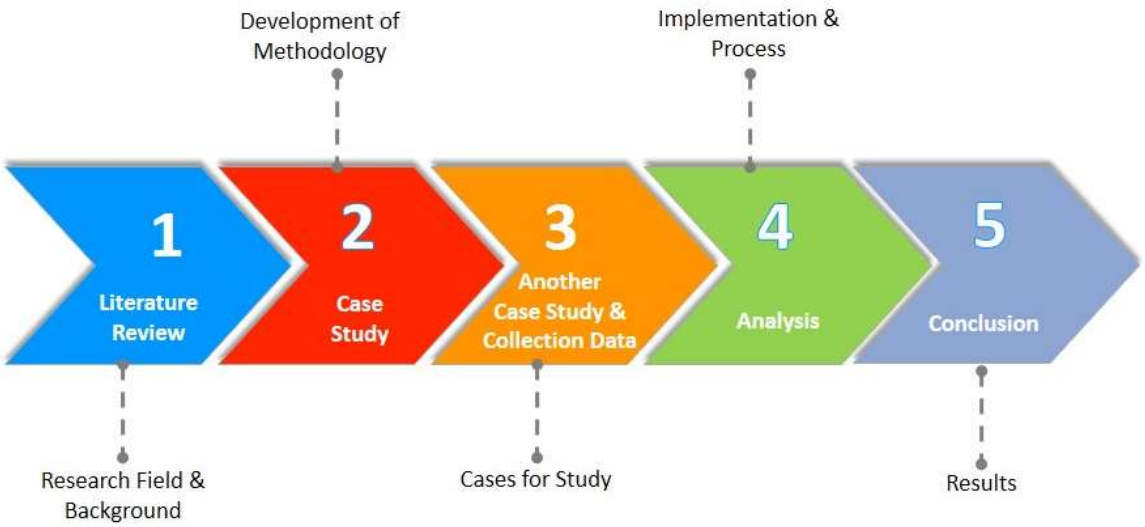



Figure 2- Summary of the methodology
Source: Author's own

### 1.4.1. Brief literature review

Various types of PLS methods have been reviewed in different articles (Usakli & Küçükergin, 2018), and various software have been used (Cepeda-Carrion et al., 2018). In the opinion of many researchers, the use of SEM is equivalent to the use of covariance-based analysis and likelihood method, but there is another form of variance-based SEM that does not rely on assumptions such as the normal distribution of the observed reagents and the large volume of samples (Alamer, 2022).

When estimating a theoretical model, there are different ways to estimate population parameters (Alamer & Elahi Shirvan, 2022). This estimate should reproduce the closest matrix to the sample matrix so that the chi-square statistic is as close to zero as possible and the GoF with the research data is proven. In order to minimize the difference between these two matrices, there are various functions, the most important of which are the Maximum Likelihood (ML) and Partial Least Squares (PLS) methods (Law & Fong, 2020).

The SEM-ML method, as a method based on covariance, forms the dominant part of structural equation analysis methods in science, but the need of researchers for better techniques led to the first book related to the use of partial least squares (PLS) based on the variance in path

models with latent variables published by Wold (1979). Herman Wold proposed the least squares (LS) approach (distributional assumptions and small sample size) against the SEM-ML (Maximum likelihood) modeling technique (many distributional assumptions and large sample size) Jöreskog 1970 (Ranjbar et al., 2020).

There are different approaches to SEM structural equation modeling:

The first approach, widely called Covariance-Based Structural Equation Modeling (CB-SEM), is performed using software packages such as AMOS, LISREL, and Mplus. The second approach is Partial Equation Modeling (PEM), which focuses on variance analysis and can be implemented using PLS-Graph, Visual-PLS, Smart-PLS, and Warp-PLS software. It can also be implemented using the PLS package in the R statistics software, but it requires certain levels of programming knowledge, so it is not suitable for people who do not know the field of computer science.

The third approach is a structural equation modeling method based on elements, which is called Generalized Structural Component Analysis (GSCA) and is implemented through Visual GSCA software or GeSCA software. Another method for implementing structural equation modeling is Nonlinear Universal Structural Relational Modeling (NEUSREL), which is implemented using NEURSEL analysis software. Faced with different approaches to path models, researchers must consider the advantages and disadvantages of each (Hair et al., 2016).

In general, there are two types of SEM: Covariance-Based SEM and variance-based SEM. In Covariance-Based SEM, by using the covariance variance matrix, one or more common factors in the model are estimated, and LISREL and AMOS software are used; in the case that in the Variance-Based SEM or the component-based method (Component-Based SEM), unlike the covariance method, means Partial Least Squares (PLS). PLS path modeling is used to predict dependent variables (latent and manifest) and for confirmatory analysis, but the CB-SEM method is more suitable for exploratory analysis (Chin W. W., 2010), and latent variables cannot be obtained in it (Chin et al., 2020).

Covariance-Based Structural Equation Modeling (CB-SEM) has been widely used in social science fields in recent decades and is still the preferred method for statistical analysis to confirm or reject theories through hypotheses testing (Hair et al., 2014). This method is preferred especially when the sample size is large, or the data distribution is normal, and most

importantly, when the model is specific, but obtaining a set of data that meets all these requirements is often difficult; therefore, experts may use heuristics, i.e., a mode with little information about the relationships between the variables. In this case, the researcher can use PLS.

Modeling based on partial least squares is a more moderate modeling approach than CB-SEM without any assumptions about the distribution of scores (Esposito et al., 2010). For example, the pliability in theory testing by Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Exploratory Structural Equation Modeling (ESEM) (Alamer & Marsh, 2022). In many types of research, we seek to design a tool that can effectively identify the various dimensions of the investigated factors. This questionnaire can be used to determine the effectiveness of those dimensions and factors in the studied society. Factor analysis (FA) is a way of working with large amounts of data and summarizing them into smaller sets of data that are easier to manage and understand. Factor analysis (FA) is a method for finding latent patterns and shows how patterns overlap and which features are observed in multiple patterns (Marsh et al., 2019).

Factor Analysis (FA) is divided into two general types:

1. Exploratory factor analysis (EFA): This is in a situation where the researcher has no idea about the structure of the data or the number of dimensions of variables.
2. Confirmatory factor analysis (CFA): This is for cases that have a specific idea about the structure of the data and the number of dimensions present in the variables. In this case, confirmatory factor analysis is used to check and confirm the idea.

The major differences between exploratory factor analysis and confirmatory factor analysis are (Shao et al., 2022):

Confirmatory factor analysis (CFA) requires determining the following:

- A predefined model
- Several factors
- which index belongs to which factor,
- A model supported by previous theory or research.

While exploratory factor analysis:

- Helps to determine the factor structure of the model.
- Explains the maximum amount of variance.

Therefore, PLS-SEM is a suitable option in front of CB-SEM for the following situations:

1- The sample size is small,
2- Few theories are available,
3- Prediction accuracy is higher,
4- The features of the correction model are not confirmed.

It is important to note that PLS-SEM is not suitable for all types of statistical analysis, and researchers must be aware of some of the weaknesses of PLS-SEM, which include the following:

1- Multiple collinearity problems are not managed well.
2- Because the arrows are always unidirectional, it is not possible to check two-way correlations.
3- The lack of complete continuity in the scores of latent variables may exist in the estimate of elements of load factor and path coefficients.
4- The mean square may cause a large error in the estimation of the path coefficients.

Despite these limitations, PLS is suitable for structural equation modeling in applied research projects (Hair & Alamer, 2022), especially in cases where participants are limited or when the data distribution is skewed (Skewness). PLS-SEM can be used in various fields of science, such as accounting (Nitzl, 2016), Human Resource Management (Ringle et al., 2020), behavioral sciences (Bass et al., 2003), strategic management (Hair, Sarstedt, Pieper, & Ringle, 2012), marketing (Henseler et al., 2009; Hair, Sarstedt, Ringle, & Mena, 2012), information management system (Hair et al., 2017; Chin et al., 2003), tourism (Do Valle & Assaker, 2016), healthcare (Avkiran, 2018), operation management (Bayonne et al., 2020), Software Engineering (Russo & Stol, 2021), Higher Education (Ghasemy et al., 2020), etc.

Generalized Structural Component Analysis (GSCA) and other approaches are appropriate when general measures of model fit are required or in cases where there are non-linear latent variables, in which case GSCA will be preferable to PLS for implementing structural equation modeling (Hwang et al., 2010) and for data sets, which show significant non-linear effects and

mediation among the variables, the NEUSREL approach will be appropriate (Buckler & Hennig-Thurau, 2008).

However, since GSA and NEUSREL are relatively new approaches to SEM, their theoretical background is limited. PLS is still used by many as a multivariate data analysis method. In any case, some guidelines have been suggested in the background, which are stated in Table 2:

Table 2- PLS Instructions in previous studies

| Description | Proposals | References |
|---|---|---|
| **Scale of Measurement** | Avoid using a categorical variable as an endogenous variable | (Hair J. , Hult, Ringle, & Sarstedt, 2016) |
| **The value of external weights** | Use a single value as the starting weight to approximate the current variable score | (Henseler, Ringle, & Sinkovics, 2009) & (Monecke & Leisch, 2012) & (Hair Jr., et al., 2021) |
| **Maximum number of repetitions** | 300 | (Hair Jr., et al., 2021) |
| **Re-sampling** | The number of resampling "samples" should be 5000, and the number of sampling "cases" should be the same number of valid observations. | (Hair J. , Hult, Ringle, & Sarstedt, 2016) |
| **Evaluation of the internal model** | From fit indicators (GoF) | (Hair J. , Sarstedt, Ringle, & Gudergan, 2017) |
| **External model evaluation (reflective)** | Report factor loadings and not use Cronbach's alpha for internal consistency reliability. | (Taber, 2018) & (Hair Jr., et al., 2021) |
| **External model evaluation (formative)** | Report regression weights, t-values, P-values, and standard errors for the significance test of the outer model. | (Benitez, Henseler, Castillo, & Schuberth, 2020) & (Hair Jr., et al., 2021) |

Source: Author's own

The purpose of providing the experimental conceptual design is to obtain maximum information from a series of data sets. For different purposes and experiences, experimental design can also be used. For example, to predict an optimal model for improvement, define a quantitative model that specifies mathematical relationships between variables and validates it using empirical data. Because the experiments are designed in a scientific and planned manner, time and costs are saved, which is achieved by an acceptable and systematic experimental design that examines various factors in several responses (Hair Jr. et al., 2021).

Multivariate optimization methods, such as PLS, can collect and sort various factors and data. Also, PLS regression coefficients as a measuring model can be used as a tool to show and express the importance of the impact of variables on responses. Basically, PLS has direct and inverse relationships to linear relationships between the collected data, so the relationships between the studied factors must be correctly assumed (Melssen et al., 2006).

SEM is a multivariate data analysis and processing method that is often used in the fields of engineering and data information (e.g., Trail, Kim, & Alfaro-Barrantes, 2024). Industries and engineers can use this method to analyze variable relationships and prioritize resources to improve services. They can also use latent variables in SEM, which are difficult to measure but useful for addressing complex problems.

According to Figure 3, the descriptions are:

- ❖ Latent variables: known as factors
- ❖ Endogenous variable: all operators lead to it (in the model, all arrows lead to it)
- ❖ Exogenous variable: moves to the rest of the operators (in the model, all the arrows that come out of it)
- ❖ Indicators: directly measurable - act for a latent variable

There are two sub-models available:

- Inner model: relationships between independent and dependent latent variables - structural model
- outer model: relationships between latent variables and their indicators - measurement model (Hair Jr. et al., 2021)

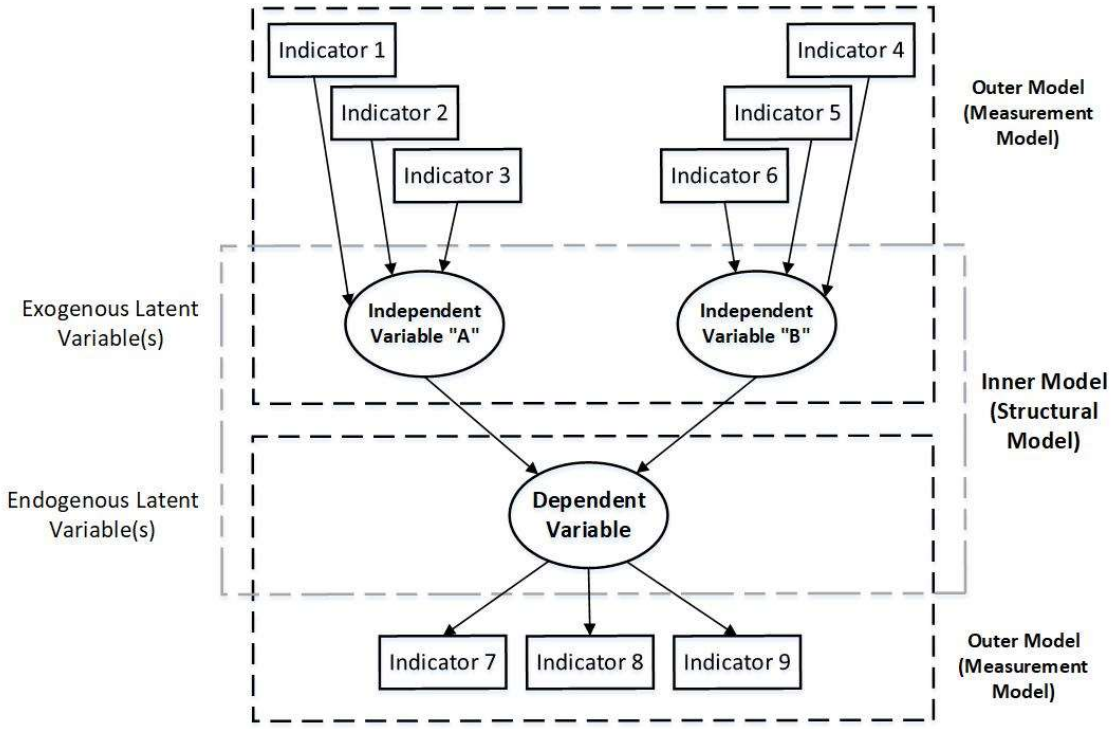



Figure 3- Inner and Outer Models in Structural Equation Modeling (SEM)
Source: Hair Jr. et al. (2021)

According to Table 2, there are two types of measurement in SEM:

- Formative Measurement Scale:

When the considered indicators create a latent variable that cannot be exchanged, these indicators are called formative. These indicators have a positive or negative relationship with each other or even have no relationship with each other. This means there is no need for the validation of indicators, the validity of internal balance, and the validity of differences. Latent variables that are created by means of unrelated actions, the square root of Average Variance Extracted (AVE), are incomprehensible and meaningless (Hair et al., 2012).

For example, to measure employees' psychological level, we consider it a latent variable and use indicators such as work stress, divorce, accident risk, and salary reduction due to delay. This approach allows us to overcome the difficulty of measuring psychological levels directly. According to these indicators, the risk of accidents has nothing to do with the indicators of divorce and salary reduction, and these indicators are also not transferable. So, when these formative indicators exist in the desired model, the direction of the arrows in the SmartPLS model should be changed.

- Reflective Measurement Scale:

If the indicators mentioned above have the ability to move and change, they are known as reflective, and their validation should be examined and tested (Hair Jr. et al., 2021). For example, a latent variable in a restaurant is considered a variable of the degree of quality of the restaurant, which can be the indicator of the taste of the food, the cleanliness of the restaurant environment, and the quality of the food served. Therefore, AVE and its square root should be investigated and tested. In this type of measurement, it should be noted that in smart-PLS, when the variables are of the reflective type, the direction of the arrows must be changed in the corresponding software so that the modes are converted from formative to reflective.

One of the statistical methods that are widely used today is Multivariate Analysis (MA). Necessary measurements of people, people of a company, activities, situations, etc., which show the number of variables and are usually done by surveys; those measurements are obtained as primary information and data. However, information may be obtained from other databases, including real information on projects and companies. Figure 4 shows two types:

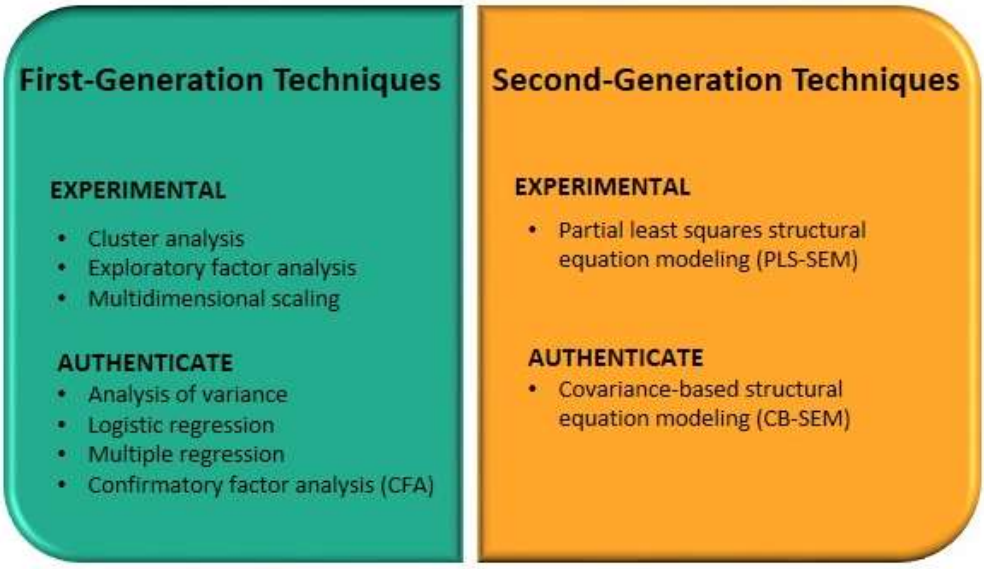



Figure 4- Multivariate Methods-Comparison of two generations
Source: Author's own

PLS-SEM is used by researchers as a forecasting method that is being developed. In the Partial Least Squares (PLS) technique, the effect size index $F^2$, determination coefficient $R^2$, $Q^2$ index, and Goodness of Fit (GoF) statistics are usually used.

**Structural model fit evaluation indices:**

In order to fit the structural model, the following evaluation indices were performed in order:

1. T-Value
2. $R^2$ index
3. $Q^2$ index
4. Redundancy index

The coefficient of determination $R^2$ is a measure that expresses the number of changes in each of the dependent variables of the model, which is explained by the independent variables. The value of $R^2$ is presented only for the endogenous variables of the model, and in the case of exogenous constructs, its value is equal to zero. The higher the value of $R^2$ related to the endogenous constructs of the model, the better the fit of the model.

The second Indicator model fit index is the $Q^2$ index. It determines the predictive power of the model in endogenous indicators. According to their belief, models that have an acceptable Indicator fit should be able to predict the endogenous variables of the model. This means that if the relationships between the indicators are correctly defined in a model, the indicators influence each other, and in this way, the hypotheses are correctly confirmed. If the value of the $Q^2$ index is positive, it shows that the fit of the model is favorable and the model is strong. It has good predictability (Chin et al., 2020; Munabi & Buwembo, 2020).

The $Q^2$ index, presented by Stone (1974), determines the predictive power of the model. Henseler et al. (2009) proposed three values to assess the predictive power of the model regarding endogenous variables: 0.2, 0.15, and determined 0.35, which respectively indicate weak, medium, and strong predictive power of the variable or the related exogenous variables.

The GoF index calculates the fit of the structural and measurement components simultaneously. This index can be calculated using the geometric mean of the $R^2$ index and the average of shared indices. The GoF criterion was invented by Jianxin Zhao, Xinmin Li (Zhao & Li, 2022), and Tenenhaus et al. (2004) and is calculated according to the following equation:

$$\text{GOF} = \sqrt{\text{average (Communality)} \times \text{average } (R^2)} \quad (1)$$

Since in partial least squares, the value of Communality is equal to AVE, Chechile and Barch (2022) provided the following formula:

$$\text{GOF} = \sqrt{\text{average (AVE)} \times \text{average } (R^2)} \quad (2)$$

Communality: average communality of all endogenous latent variables, $R^2$: average variance of all latent variables.

Table 3 describes the PLS-SEM model according to CFA (Cheung & Rensvold, 2002; Chechile & Barch, 2022; Henseler & Sarstedt, 2013):

Table 3- Formulas in PLS-SEM model according to CFA

| | |
|---|---|
| **Construct Reliability (CR)** | $\mathbf{CR} = \frac{\sum(\boldsymbol{\lambda}_{\mathbf{n,m}})^{\mathbf{2}}}{\sum(\boldsymbol{\lambda}_{\mathbf{n,m}})^{\mathbf{2}} + \sum(\mathbf{Var}_{(\boldsymbol{\varepsilon}_{\mathbf{n,m}})})}$ |
| **Average Variance Extracted (AVE)** | $\text{AVE} = \frac{\sum_{(\text{Communalities})}{}^{2}}{\text{n}}$ |
| **Blindfolding Criteria Index** | $F^2 = \frac{R^2_{\text{included}} + R^2_{\text{excluded}}}{1 - R^2_{\text{included}}}$ |
| **Goodness of Fit (GoF)** | $\text{GoF} = \sqrt{\overline{Communality} \times \overline{R^2}}$ |
| **Coefficient of Determination** | $R^2 = 1 - (\frac{L(0)}{L(\propto)})^{\frac{2}{n}}$ |

$\varepsilon = \text{Error}, \lambda = \text{Factor loading}, R^2 \text{in } F^2 = \text{Path coefficient},$
$L(0) = \text{likelihood of the model with only the intercept}, L(\propto) = \text{likelihood of the estimated model}$
Source: Latan et al. (2023); Henseler & Sarstedt (2013); Tenenhaus et al. (2004); Hair Jr. et al. (2021)

One of the issues in statistical analysis is the examination of data distribution. If one can be sure that the data follow a certain distribution, then statistical analyzes and tests have more validity than if the distribution is not known. These tests are known as "Goodness of Fit (GoF)". The GoF index is related to the overall fit of structural equation models. This means that with this criterion, the researcher can control the fit of the overall part after checking the fit of the measurement part and the structural part of the overall research model. The closer the GoF index is to one, the more suitable the model is.

Three values to evaluate the GoF index (Henseler & Sarstedt, 2013; Faizan, Amin, & Cobanoglu, 2015; Chechile & Barch, 2022):

- Weak: if it is between 0.1 and 0.25.
- Average if it is between 0.25 and 0.36.
- Strong: If it is more than 0.36.

The effect size $F^2$ is another indicator of the fit of the structural part of the model and is valid for external independent variables. The effect size index was introduced by Jacob Cohen, and it was also discussed in the discussion of calculating the Cohen index. The $F^2$ index for an independent variable shows the number of changes in the estimate of the dependent variable when the effect of that variable is removed.

According to Cohen (Cohen, 1988), the value of this index is 0.02 (weak), 0.15 (moderate) and 0.35 (strong).

- Between 0.02 and 0.15: little predictive power
- Between 0.15 and 0.35: average predictive power
- More than 0.35: high predictive power

The coefficient of determination is used to calculate the effect size.

$$F^2 = \frac{R^2_{\text{included}} + R^2_{\text{excluded}}}{1 - R^2_{\text{included}}} \quad (3)$$

Based on the above relationship, it is sufficient to calculate the coefficient of determination once the effect of the desired independent variable is considered and calculated by removing this effect. Then, the calculated value should be interpreted based on Cohen's suggested values.

For a better understanding of evaluation indices in SMART-PLS, Table 4 is shown:

Table 4- Understanding of SMART-PLS with different intervals

| SMART-PLS | Description | Ratio |
|---|---|---|
| **$R^2$** | The variance in the endogenous variable | (Falk & Miller, 1992): $R^2 \geq 0.10$<br>(Cohen, 1988): $R^2 < 0.02$, $0.02 \leq R^2 < 0.13$, $R^2 \geq 0.26$<br>(Chin, W.W., 1998): $R^2 < 0.19$, $0.19 \leq R^2 < 0.33$, $R^2 \geq 0.67$<br>(Hair J., et al., 2016) & (Hair J., et al., 2011):<br>$R^2 < 0.25$, $0.25 \leq R^2 < 0.50$, $R^2 \geq 0.75$ |
| **$F^2$** | Effect on the dependent variable by removing an exogenous variable | Cohen (1988): $F^2 < 0.02$, $0.02 \leq F^2 < 0.15$, $F^2 \geq 0.35$ |
| **$Q^2$** | If the relationships between the variables are defined correctly, they have sufficient influence on each other | (Henseler, et al., 2009) and (Stone, 1974):<br>Good $> 0$<br>Run the Blindfolding procedure in SMART-PLS |

Source: Hair Jr. et al. (2021)

T-Value:

The t-statistic is the coefficient divided by its standard error, and the measurement precision is the regression coefficient. The most basic indicator for measuring the relationship between variables in the model (structural part) is more significant numbers (Hair Jr. et al., 2021). If the value of these numbers at the 95% level exceeds 1.96, it indicates the correctness of the relationship between the variables (Davari & Rezazadeh, 2016).

Redundancy index:

This index indicates the variability of the questions of an endogenous variable that is affected by one or more exogenous variables (Davari & Rezazadeh, 2016).

Cronbach's alpha index:

Cronbach's alpha indices, composite reliability coefficient (CR), and average variance extracted (AVE) are also reported in the SmartPLS structural equation software for confirmatory factor analysis.

Cronbach's alpha coefficient and composite reliability coefficient are among the methods used to measure the internal consistency of the questionnaire. Cronbach's alpha is obtained based on the average covariance (or correlation) of the questions in a questionnaire. Usually, positive values above 0.7 are considered appropriate (Table 5), and if they are negative, they indicate high heterogeneity (incompatibility). Another method to check internal consistency is the composite reliability coefficient, which is obtained based on factor loadings.

Cronbach's alpha coefficient was introduced by American psychologist Lee Joseph Cronbach in 1951 (Cronbach, 1951) to measure homogeneity reliability. This reliability coefficient refers to the ability of a tool to measure continuously, in this way, to what extent all the components of a scale express the same concept and show the internal relationship of these components. One of the most widely used of them is Cronbach's alpha coefficient, which is obtained based on the average covariance (or correlation) of questions (objects, items) in a questionnaire (test). When there are several subscales in the questionnaire, alpha is calculated separately for the subscales.

Consider a multiple-choice "questionnaire" whose first k questions are designed to measure a specific concept or dimension. Suppose this value (variable $X$) can be measured based on the sum of several questions (items) that exist in the questionnaire. If we indicate the items with $Y_k$, we write their relationship with $X$ as follows:

$$X = Y_1 + Y_2 + \cdots + Y_k \quad (4)$$

Cronbach's alpha can be used for all scales whose level of measurement of the indicators is rank, interval, or relative. To calculate the Cronbach's alpha coefficient, first, the variance of the scores of the questionnaire questions and the total variance (the variance of the total scores) should be calculated, and then using the following formula:

$$\propto = \frac{K}{K-1}\left(1 - \frac{\sum S_i^2}{S^2}\right) \quad (5)$$

$K$ is the number of items, $S_i^2$ is the variance of item i, and $S^2$ is the variance of the total scores of the items (Raykov & Marcoulides, 2019).

After simplification, finally:

$$\propto = \frac{K \times average\ (cor_{ij})}{1 + average\ (cor_{ij}) \times (K-1)} \quad (6)$$

$K$ is the number of items, and the $average\ (cor_{ij})$ is the average of the correlation matrix.

Table 5- Rule of Thumb for Results Cronbach's Alpha

| Internal reliability | Cronbach's alpha coefficient value |
|---|---|
| Excellent | $\propto \geq 0.9$ |
| Good | $0.9 > \propto \geq 0.8$ |
| Acceptable | $0.8 > \propto \geq 0.7$ |
| Questionable | $0.7 > \propto \geq 0.6$ |
| Poor | $0.6 > \propto \geq 0.5$ |
| Unacceptable | $0.5 > \propto$ |

Source: Hair Jr. et al. (2021)

Cronbach's alpha is also used to relate items with latent variables. This means that the items that have the highest coefficient can represent a latent variable. As a result, the value of the latent variable can be calculated by the sum of their scores (Bonett & Wright, 2014; Bujang et al., 2018).

The composite reliability (CR) method, compared to Cronbach's alpha method, requires a larger sample size to be calculated, and for this reason, usually, when determining the sample size in the initial sampling (especially when the initial sample is small), Cronbach's alpha (which is in the volume) small samples can also be calculated are used to check the reliability of homogeneity. After the end of the data collection stage, both Cronbach's alpha coefficient and CR coefficient can be reported.

This coefficient is calculated as follows:

$$CR = \frac{\left(\sum_{i=1}^{k} \lambda_i\right)^2}{\left(\sum_{i=1}^{k} \lambda_i\right)^2 + \sum_{i=1}^{k} (1-\lambda_i^2)} \quad (7)$$

$K$ is the number of items, and $\lambda_i$is the Standard operating load of Item Number $i$.

Acceptable values for $CR$ are values above 0.7 $(CR > 0.7)$.

Bootstrap: sampling by replacing a main sample many times. That is, from a fixed sample with a limited volume, resampling is done many times, of course, with replacement, until finally, a sample distribution is obtained from all the obtained results, which is often more than 200 times. An empirical sample distribution is a basis for calculating the standard error (Zhu, 1997).

Standardized Root Mean squared Residual (SRMR):

SRMR is the difference between the observed correlation and the correlation matrix of the structural model. The closer this criterion is to zero, the better the Goodness of Fit Index (GFI) is, which means that if it is less than 0.08, it is suitable (Hu & Bentler, 1999).

RMS Theta:

One of the very good indicators for evaluating reflective measurement models is not interpretable for formative models. Its basis is the correlation between error variables or residuals. The smaller these correlations are, the smaller the RMS index is, and it is more desirable that the best value is zero; the most suitable is below 0.12 (Lohmoller, 1989).

Heterotrait-Monotrait ratio of correlations (HTMT):

HTMT method is proposed to evaluate the discriminant validity in SEM (Henseler et al., 2015), which is used in structural equation modeling. There are two methods to use it: HTMT matrix comparison with specified limits, i.e., 0.85 or 0.90, and another method using Bootstrap that shows the correlation between two latent variables. The easy calculation is one of its advantages due to the need for a correlation matrix (Henseler, Ringle, & Sarstedt, 2015; Franke & Sarstedt, 2019).

## 1.5. CONCLUSION

In general, there are three steps regarding CRM:

1. Getting new relationships:

   By maintaining and gaining leadership and advancement in the product or service offered, new relationships can be gained.

2. Strengthening relationships:

   By providing incentives, innovations, and increasing sales of products or services, relationships can be strengthened.

3. Maintaining current relationships:

   Continuity in providing the necessary services, after-sales services, creative warranty services, and old relationships can be maintained.

In line with the above factors, the following steps can be taken to improve ECRM:

Developed a comprehensive, up-to-date database and performed real-time analyses to predict market behavior. Expanded customer base and introduced new services and products tailored to customer needs. Encouraged customer engagement and monitored their behavior through ongoing real-time analysis.

According to the nature of the Case-Study projects, some or all of the following factors have been used to study the subjects:

The levels of customer relationship management can be divided into the following categories:

a) Strategic management of relations with customers
b) Operational management of relations with customers
c) Structural management of relations with customers
d) Analytical management of relations with customers

The phases of the approach for developing CRM strategies can be expanded in the following ways (strategy management):

Phase 1: Identification of value-creating factors

- Examining the existing market:

  Examining the existing market involves gathering data on the market's size, trends, and competition. This can help a business understand where it fits in the market and identify potential areas for expansion.

- Customer grouping:

  Customer grouping involves segmenting customers based on common characteristics such as demographics, behavior, or needs. This allows businesses to tailor their marketing and sales efforts to specific groups of customers, improving the effectiveness of their outreach.
- Value-creating factors in the relevant industry:

  Value-creating factors in the relevant industry refer to the elements that drive success and profitability within the industry. This could include factors such as innovation, efficiency, or quality. By understanding these factors, businesses can better position themselves to compete and succeed in the market.
- Value-creating factors for customers:

  Value-creating factors for customers refer to the elements that are most important to customers when making purchasing decisions. This could include factors such as price, convenience, or quality. By understanding these factors, businesses can better meet the needs and preferences of their customers, leading to increased satisfaction and loyalty.
- Value-creating factors for services:

  Value-creating factors are the elements that make a particular service offering valuable to customers. This could include factors such as expertise, responsiveness, or customization. By understanding these factors, businesses can improve the quality and effectiveness of their service offerings, leading to increased customer satisfaction and retention.

Phase 2: Formulating the CRM strategy (customer grouping)

- Preferences in relationships
- Preferences in communication channels
- Preferences in goods and services
- Priorities in customer service

Phase 3: operationalizing the CRM strategy

- Service and sales

- Management of customer processes
- Customer experience standards
- Customer information management

Critical factors of success that must be paid attention to:

I. Financial support of operations
II. Drawing the conceptual model
III. Budget
IV. Collection of requirements
V. Data mapping
VI. Correct selection of tools
VII. Satisfying the demands of users and testing the efficiency of the system

Models and implementation requirements involved in projects:

- Creating a multitasking project team through different units of the organization
- Preparing a report for the recognition and evaluation phase of the organization's current situation in relation to the supply chain
- Creating a strategy including goals and ideals for a customer-oriented organization
- Determining the goals of the project and disseminating it among all the employees of the organization
- Determining the existing situation with the customer's contact points with the organization, the personnel situation in the organization, the process situation in the organization, and the technology situation in the organization.
- Mapping processes in the ideal state in the future with a focus on business activities (and not on technology)
- Determining functional requirements in order to determine and choose the appropriate technology
- The beginning of storage and cleaning of information related to customers
- Creating strong relationships and sustainable partnerships with customers
- Establishment and implementation of strategy and strategic plans

- Rearranging organizational units to encourage communication and coordination between employees to support customers (sales, marketing, and after-sales service units)
- Establishing an employee evaluation and motivation system in order to strengthen customer-oriented behaviors and value chain goals
- Use of selective technology

Three types of decisions can be made regarding the above issues:

- Decision-making about solving a broad problem
- Decision-making about solving the limited problem
- Deciding on the solution to the assigned problem (routine)

Extracting the influencing factors on customer behavior from the proposed models:

In the basic conceptual model under study, Figure 5 includes the following components:


Figure 5- Basic conceptual model Components
Source: Author's own

In this model, in Figure 6, the influencing factors are as follows:

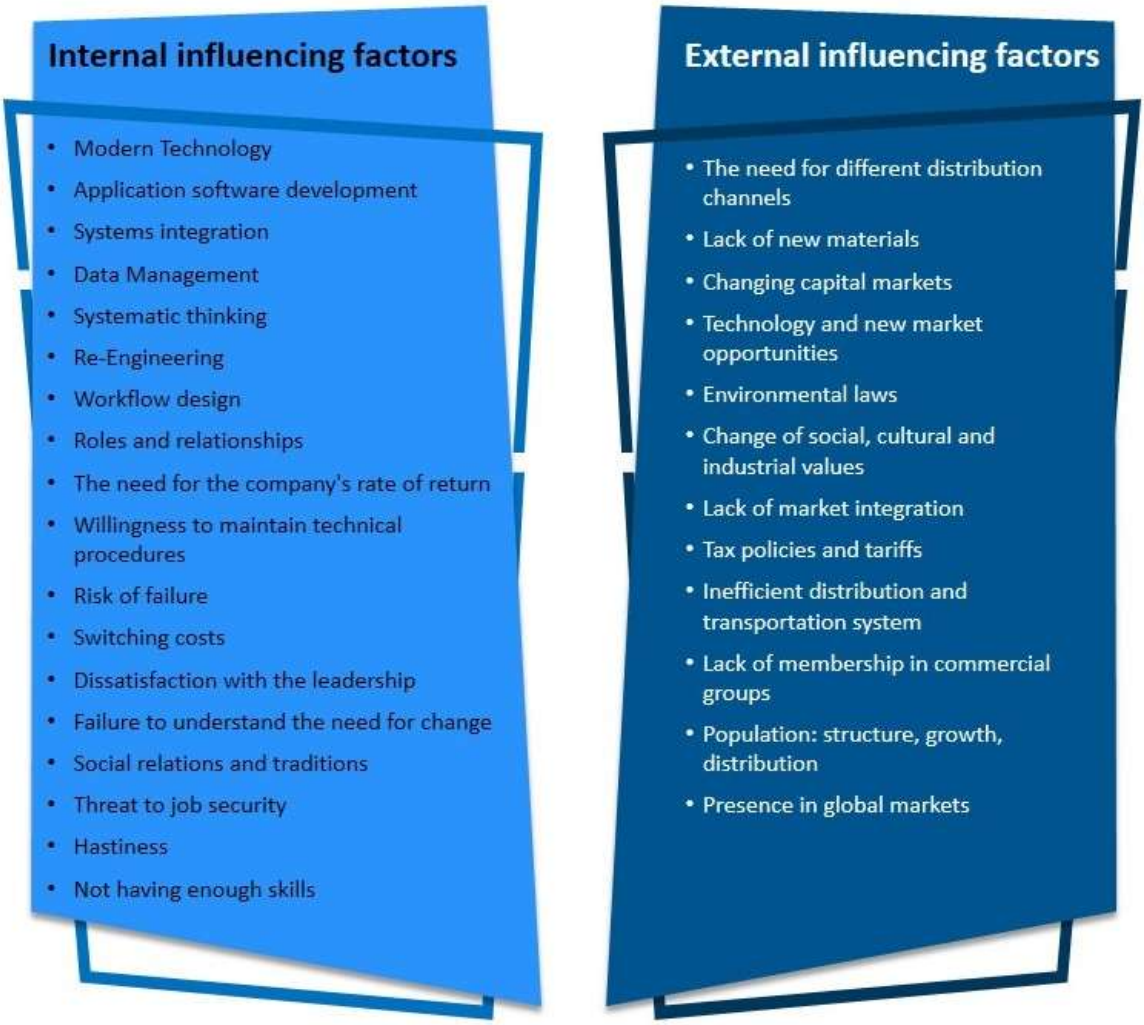



Figure 6- Influencing Factors in Basic conceptual model
Source: Author's own

# Chapter 2
# Literature Review

## 2.1. Introduction

The idea of Relationship Marketing (RM) was initially introduced by Berry (1983) and later by Jackson (1985). The importance of cooperative relationships in communication and long-term sustainability was highlighted by Dwyer et al. (1987). In 1990, Grönroos emphasized that profitable relationships contribute to the longevity of these relationships. Morgan and Hunt (1994) expressed the development and maintenance of relationships at a high level as part of relationship marketing. Sin et al. (2005) differentiated between customer relationship management and targeted marketing, stating that customer relationship management is used tactically in management, while marketing is an emotional, behavioral, and targeted relationship between two parties. Despite this, Kevork and Vrechopoulos provided a classification for relationship marketing in 2009. Awasthi and Sangle (2012) presented new literature on relationship marketing in the context of CRM environments.

Ever since the Internet entered various fields, businesses, organizations, and daily life, including customer relationships, supply chain, education, government, industry, telecommunication, communication, etc., and created various connections, special and unique attention to a person came to it and has witnessed the increasing growth of its use in the situation of consumer, business, industry and market (Bradshaw & Brash, 2001). For this reason, organizations and companies should rethink the way they communicate with their customers and stakeholders (Yoon et al., 2008).

Stakeholders and customers in today's market have a decisive role that causes the strategic determination of companies and the development of organizations. Considering this issue, the Internet has improved Customer Relationship Management (CRM), made communication and interactions in this market better, and strengthened new relationships (Tavana et al., 2013). The main part of CRM is creativity, technology, adaptability and strategy, which are used in organizations for communication and interaction, time management, participation and cooperation, effective feedback, and coordination (Kulpa, 2017).

The world is trending towards technology, which causes many complications and many opportunities for companies and society (Nguyen et al., 2018). CRM in business creates long-term relationships with customers. In this regard, different ways can be done, and one of the best ways is electronic ways, such as e-business or e-commerce, which is a solution to expand

communication (Rosalina, 2019). Information and data in companies are obtained from various sources, customers, and stakeholders and are collected from the information of customers and branches. Analyzing these data helps to obtain a model that will lead to different strategies (Shams et al., 2020).

In this regard, the management of big data causes different strategic issues and decisions to be made, and this information helps in these matters (Chatterjee et al., 2021). In the studies conducted, it has been found that wrong decisions are caused by the lack of correct and efficient management (Piccolo et al., 2021).

Consequently, the trend toward technology has created many opportunities and complications for companies and society. CRM in business aims to create long-term relationships with customers, and one of the best ways to achieve this is through electronic means such as e-business or e-commerce. Information and data from various sources, including customers and stakeholders, are collected and analyzed to obtain models that lead to different strategies. In this regard, managing big data causes strategic issues and decisions, and efficient management helps. Studies have shown that a lack of correct and efficient management often causes wrong decisions. Therefore, organizations must prioritize efficient big data management to make informed strategic decisions (Chatterjee et al., 2022).

## 2.2. Electronic Customer Relationship Management

A large number of studies and research have investigated the effects of ECRM, which has resulted in high customer satisfaction (Al-Dmour et al., 2019; Upadhyaya, 2020), Keeping customers and shareholders (Al-Dmour et al., 2019; Azila & Noor, 2012), customer allegiance (Mang'unyi et al., 2018; Shastri et al., 2020), being profitable (Rastgar et al., 2019). Considering that ECRM has a great reputation, however, in profitable companies with developing financial conditions, there have not been enough detailed studies (Shastri et al., 2020).

There are various reasons for not paying much attention to it, such as organizational culture, lack of financial attractiveness, different internal rules, restrictions on corporate practices, and different economic cultures (Khan et al., 2020). After the introduction of e-commerce and the provision of all services based on the Internet, the focus of ECRM was established, which is more effective and useful due to its cost-effectiveness and the creation of a higher sense of responsibility. In a commercial transaction, the customer determines whether the transaction continues or ends (Hopkins & Potcovaru, 2021).

A study has been conducted in this field, which shows that paying attention to customer loyalty and retention plays an important role in predicting customer satisfaction (Santouridis & Veraki, 2017). According to the opinion that CRM simplification is defined by ECRM (Chaston & Mangles, 2003), and the ability of ECRM, its features can be used for customer loyalty for a long-term relationship. Communication channels such as social networks (Verhoef et al., 2010), Websites and forums (Simmons et al., 2008) are important tools for businesses to engage with customers and stakeholders. Integration in CRM causes the expansion of ERCM, which can also be done in wireless and radio technologies. ECRM system can make the relationship between employees, organizations, and companies better and stronger because ECRM has different dimensions such as employees, system, advanced technology and organizing procedures (Damabi et al., 2018). CRM is integrated with technology, so technology is one of the main elements of ECRM (Almajali et al., 2022).

Feinberg & Kadam (2002) emphasized the importance of 42 features of ECRM due to the online use of websites to sell and introduce their products and services, such as product customization, complaint ability, service and product tracking, and up-to-date online

communication. Moezzi, Nawaser, Shakhsian, and Khani (2012) pointed out that the increase in investment in companies that have deployed ECRM systems is more; as a result of this issue, it can be a tool for providing services to customers and shareholders. Hamidi and Safareyeh (2019) have focused on the that through ECRM, it is possible to determine the policy of an industry and company, which customers' ideas can be decisive in its regulation. As a result, financial transactions in developing countries based on electronic commerce are increasing (Almajali et al., 2022).

## 2.3. Strategic management

The development strategy of technology and information infrastructures in organizations and companies gives these organizations many competitive advantages over others. The structure of CRM includes a set of strategies that contain marketing and commerce that can integrate information technologies with organizational procedures and customers and perform practical and qualitative analyses to increase profits and reduce costs (Varajão & Cruz-Cunha, 2016). Without considering information technology and its development as a strategy to collect and analyze information and data of shareholders and customers, establishing strong relationships with people, companies, and organizations cannot have long-term benefits and competitive advantage (Bahrami et al., 2012).

In another study, it has been determined that in the 21st century, when new generation technologies and innovations have been introduced and will be, digitalization plays an important and direct role in people's lives, and the strategy of focusing on CRM can create new opportunities and situations for the company (Giannakis-Bompolis & Boutsouki, 2014). A strategic technique for CRM is that through it, organizations can create a competitive advantage, which includes creating key relationships with customers and employers, more profitability, and providing better services (Ahani, Ab. Rahim, & Nilashi, 2017).

The electronic environment, together with information technology, can create unlimited access regardless of geographical location. ECRM strategy can also be implemented in the international environment. The ECRM system can be created through the Internet and by using hardware, software, processes, and applied processes, which can provide all the necessary services for companies and organizations to provide customers with integrated and extensive management (Yu et al., 2015). The basis of marketing literature includes ECRM strategy. The concept of Stray CRM is that the capital and assets of the company should be preserved and planned for the long-term maintenance of the organization (Zerbino et al., 2018).

In addition, it can be mentioned that the ECRM strategy is the concept of transferring a set of human resources to an automatic model to express intensive interactions, for which information technology and the Internet were used to achieve success and further growth. Also, ECRM can bring an organization to the maximum value in the industry (Navimipour &

Soltani, 2016). The integration of marketing and e-commerce with each other has led to the growth of export performance for exporters who use information technology. By using the capabilities of ECRM, it is possible to provide a lot of assistance to export affairs (Gregory et al., 2019).

Recently, Hamidi and Safareeyeh (2019) have pointed out that a CRM system is a procedure that is built according to a common definition for customers that is completely confidential to create great value. In order to create long-term relationships with customers and value creators, data and all information can be collected and analyzed, and the necessary strategies can be improved through them. In new-generation technologies, the CRM process should create value for customers, which can be done by information technology (Zerbino et al., 2018).

The levels of strategy development are different. Pozza (2018) recently divides it into three levels for new technologies, including operational CRM, analytical CRM, and collaborative CRM. For Operational CRM: Big changes in new technologies are mechanized by operational measures. The focus of these measures is on operations such as information gathering, functional recognition of customers, quick and appropriate response, examining profitable customers, and providing value and adaptability. Analytical CRM: Analyzing data and information and transferring it to all levels and branches of companies. Collaborative CRM: It is used to interact with customers and the organization to gather the necessary information and data through new technologies (Pozza et al., 2018).

Strategy in a company is considered as a general principle that managers and organizations adapt to the rapidly changing market and environment, remain profitable in the long term, and use their limited resources in a way that stabilizes the company's economic situation. The type of strategy chosen completely depends on the market analysis. Its effectiveness should increase the volume of sales and profitability, satisfy consumer demands, adapt the company's capabilities to the market situation, and achieve the company's goals (Poita et al., 2022).

## 2.4. Supply chain management

The goal of SCM is quick access and customer needs concerning increasing the profit of the organization. Therefore, a hypothesis presented is that direct contact in the CRM system is integrated with SCM, and for this reason, customer communication and contact will be more successful and efficient, and the company will make more profit (Tseng & Liao, 2015). For example, Amazon company has huge warehouses to make fast distribution across countries, which is a point for the relationship between CRM and SCM (Amazon supply chain management case study, 2021).

For companies that have or use information technology, the integration of CRM and SCM can help improve the supply chain, analyze data, and increase satisfaction (Gencer, 2020). Supply Chain Integration (SCI) refers to procedures that flow inside and outside of a company and are coordinated with each other; The traditional supply chain only flowed within the borders of the company to supply the chain, while in the new supply chain, the integration of the supply inside and outside the company is chained and coordinated (Alshurideh, 2016).

In the functional and experimental study, it has been shown that logistics management and supply chain are an inseparable part of sea, air, and land transportation, and it is an emergent trend regarding integration and diversity in terminal and transportation operations (Yang, 2016). Supply chain orientation and supply chain management have the advantage of realizing their management philosophy, and they are processes that can facilitate the internal integration of the organization, suppliers, and customers through CRM. One of the results of proper productivity is that CRM can be used as a tool for sales and marketing, from HR to customer service providers, and the supply chain can use it. Another aspect of using SCM and CRM is customer selection, which is effective in improving the marketing process, and makes supply chain management more effective (Lasyoud & Alsharari, 2017).

CRM software should not be complex and challenging. Otherwise, it will be repeated and not all of its operators will be used. Return on investment (ROI) with a CRM program is very difficult in a short period. Therefore, the training and motivation of the employees should be included in the program to develop and implement it successfully. Various companies use customer-oriented strategies, programs, and technologies in relationships with customers with proper management. With organizational knowledge, culture, and customer integration,

relations with customers can be made more efficient to cause multiple purchases and orders and create a valuable mutual relationship from an economic point of view (Alshraideh et al., 2017). Technological advancements such as Artificial Intelligence (AI), Big Data, Blockchain, Cloud, and the Internet of Things (IoT) are utilized in supply chain management. Digitalization of the supply chain in its first stage is effective in business development. The nature of the competitive market has made the use of innovative technology and technologies. The existence of new technologies in supply chain management has beneficial effects in increasing productivity. Therefore, the most significant practical accomplishment of this approach is its ability to lower expenses and boost productivity (Baha, 2023).

The integration of artificial intelligence and CRM helps to analyze a large volume of information easily in less time (Chatterjee et al., 2019). To get maximum potential and success in business, artificial intelligence is used in CRM (AI-CRM). That is, in order to gain integrity and stability, especially in times of crisis and epidemics, information collection by means of technology in this field leads to the preservation of businesses (Chaudhuri et al., 2021).

## 2.5. Business Management

The main component of the business is the existence and presence of customers. With business management and the presence of CRM, it is possible to meet the customer's demands and act in line with the heart of the business (Krishna & Ravi, 2016; Erdil & Öztürk, 2018). By adopting a customer orientation approach and maintaining it through ECRM, businesses can reduce operational expenses, enhance their brand image through strategic planning, increase their market share, and gain a competitive edge. In addition, ECRM is more than a tool for marketing management and actually helps business management to perform better and use the latest information technologies to achieve more profit (Benitto & Kumar, 2015). Today, the world is considered to be technology-oriented, which provides countless opportunities in commercial society and is unique to companies and organizations (Nguyen et al., 2018).

Social CRM can improve business management performance in Small and Medium-Sized Enterprises (Ainin et al., 2015). Several researchers have found that social CRM has not been investigated in business management. This type of operation helps organizations to take time for each person individually and review cases interactively and quickly (Charoensukmongkol & Sasatanun, 2017; Kamboj et al., 2018).

The more the number of data, the more complex the business models become. Therefore, organizations must change their current methods and procedures and use Big data analytics because they can improve strategic sales performance by using CRM (Mikalef et al., 2017; Mikalef et al., 2020).

Considering the availability of information and the Internet, this issue is considered an advantage for business models. The information available on the Internet forces buyers to use it for physical and in-person purchases. Therefore, the deeper and more useful the information is, the more effective it is for online purchases and their usefulness (Cho & Sagynov, 2015). Festa, Safraou, Cuomo, and Solima (2018) have pointed out that Big data analytics will coordinate and package business management, which will lead to profitability. Big data analytics helps business management to collect the amount of information and data obtained with technology and at a high speed (Chatterjee et al., 2021).

With the entry of industries into the digital era, there have been changes in the behavior of digital consumers, which is necessary for companies to update themselves for this issue so that they can develop their operating system in the direction of commercialization. Therefore, in order to create easy purchases for customers, business management must update their systems to increase trust and loyalty in business and improve e-commerce (Jih, 2011). Real-time analytics can be considered a new technology to help business management collect business information and data by considering information technology and complex technologies (Ghosh et al., 2020a).

Suppliers and consumers are facing the rapid growth and development of technology and technology in the market. Its advantages for suppliers can be mentioned as saving money, improving the supply chain, and expanding rapidly in the market (Le Tan, 2017). Therefore, CRM is required to provide an attractive environment for businesses to strengthen relationships with customers. As a result, business management, along with e-commerce, is a successful business for the business sector. Despite many advantages, a lack of trust and loyalty can be one of the obstacles to business. Therefore, the company has turned to advanced technologies, such as advanced global electronic commerce platforms, commercialized business management, and the Internet of Things (IoT) (Bodla & Ningyu, 2017). Therefore, ECRM is a global business that relies on the Internet for business management. It has been created as a business process that considers the behavior of customers and buyers. In addition, CRM in business management technically includes data collection, analysis, modeling, and creating an approach for sustainable and lifelong relationships (Libai et al., 2020).

## 2.6. Product Development and Innovation

The innovation process for product innovation is a new solution for production (Terán-Bustamante et al., 2021). Open innovation creates competitiveness between organizations and companies and, at the same time, provides more valuable services and products (Hizam-Hanafiah & Soomro, 2021). For this issue, all organizations must have the necessary cooperation, including universities, government organizations, suppliers, and society (Valdez-Juárez et al., 2021).

One of the results of creating open innovation is efficiency and quick response of companies. Other results can be mentioned: environment, economy, and sustainability (Semin et al., 2021). Open technology is specific to any company that is based on change management, reengineering, process framing, and openness to accepting external information (Chandler & Krajcsák, 2021). López-Balboa, Blanco-González, Díez-Martín, and Prado-Román (2021) have pointed out that game innovations that lead to profitability bring satisfaction to the company's shareholders. Also, service companies cooperating with product manufacturers can achieve more profitability with the help of innovation.

In emerging economies, organizations, and even developing countries, because they have limited internal knowledge, the use of open innovation allows them to gain new competitive advantages (Yun et al., 2020). Some researchers have pointed out that open innovation has given better results in medium and open companies, and, in this regard, they have succeeded with proper advertising (Hizam-Hanafiah & Soomro, 2021). E-commerce businesses can satisfy the electronic demands of customers in the world of foreign trade through innovation (Valdez-Juárez et al., 2021).

The Internet is used to buy products, search for information, and other transactions (Lee et al., 2016). According to the advantages of financial transactions in electronic commerce, various options are available to consumers, including more products at lower prices, transactions at any time and in any place, and access to more accurate information about each product (Le Tan, 2017).

Due to the fact that businesses have been transformed by e-commerce, companies that are launched using innovative models can achieve new prospects for business processing (Khanh et al., 2021; Almajali et al., 2021; Yang & Babapour, 2022).

To ensure the sustainability and growth of a company, various efforts are made to attract and retain customers. One such effort is adopting Electronic Customer Relationship Management (ECRM) as an innovative practice. According to Kumar, Mokha, and Pattnaik (2022), ECRM applications are designed to support companies' business strategies. In addition, ECRM and e-commerce can provide valuable assets in developing and innovating products and processes within companies. By improving customer relationships through ECRM, organizations can enhance their readiness for profitability. Trust is a crucial element in building strong customer relationships and improving the quality of these relationships (Kokthi et al., 2022).

In different studies (Frimpong et al., 2020; Rydell & Suler, 2021), the existing technology in the country determines the acceptance of innovative technologies and product development. As a result, ECRM can be used to maintain and satisfy customers and can be a standard for organizations' studies (Smith & Machova, 2021).

## 2.7. Decision Making

Descriptive theories are formed based on behavior and focus on decisions, and there is no limit to them. The descriptive theorist seeks decisions based on real conditions (Shaban, 2005). The CRM system changes based on the customer's decisions, which causes changes in the next versions of CRM. Therefore, the changes in CRM will change the behavioral patterns of customers. In this context, several studies have been conducted to investigate this matter (Butu et al., 2020; Loxton et al., 2020). In the first study, the role of the media is in the decision-making and buying process of the customers, which shows the analysis of their behavior based on the factors of the public environment, and the second study highlights the priorities of consumers and their decision-making process regarding the type of purchases they make. The study employs a social CRM (SCRM) analysis, which focuses on enhancing customer relationships and sustaining these relationships over time. After the analysis and evaluations, a framework has been proposed to maintain long-term relationships with customers and decision-making processes for interaction with the media (Lamrhari et al., 2022).

The more the experience of companies in contact with customers increases, the more these experiences can be used in all different levels of decisions and consumption processes, which include pre-purchase, purchase, and post-purchase (Jain et al., 2017). In new management models, decision-making is based on a model that considers environmental, economic, and social effects and maintains organizational policies and customer values (Yu & Xu, 2022).

Consumers, based on their experiences, especially emotional shopping experiences, guide the CRM system, which can be used to save money (Wang et al., 2018). This issue can be implemented if the organization collects and analyzes customer data outside the company, and the response is carried out in a unified manner inside the company, which causes simultaneous analysis and development. With the progress in machine learning technologies, information can be collected, especially from the media, and improved with ECRM systems (Perez-Vega et al., 2021).

Data mining algorithms can be used in the decision-making process to extract information; based on its output, companies can implement decision-making processes, and this information can be stored and reviewed in a platform. The use of a decision support system

can be used to predict customer behavior (Chung & Gray, 1999). Data mining technology is a part of knowledge that must be separated from a large number of information and data obtained. After analyzing the data, it leads to modeling. Different algorithms and models are used for data mining (Moro et al., 2014). In decision-making processes, sustainable methods in electronic commerce guarantee the company maintains its values (Hanaysha & Al-Shaikh, 2021).

Therefore, the use of information technology in decision-making by organizations and providing services to customers and the data obtained from consumer interactions are considered important (Cao & Tian, 2020).

## 2.8. Employees

CRM can provide valuable information to employees and their managers in line with the goals of the organization (Mohammed et al., 2017). By creating and improving the organizational culture among the employees in the companies through an integrated and new system, it is possible to institutionalize the customer's value in the companies and the goals of the company. The community of employees should include the employees of production, service, wholesalers, small and large branches, etc., by emphasizing customers as the main priority, by sharing organizational knowledge and information in all units and parts, services can be made easier (Soltani & Navimipour, 2016). The direct relationship between CRM and customer satisfaction is influenced by the development of employee behavior, the Internet, and the quality of electronic services (Wong, 2020).

Product features, performance, etc., should be explained by the employees, and communication with customers should be user-friendly (Foya et al., 2015). The context that digitalization and technologies create in organizations, the culture and goal setting between employees, and inter-organizational and company-wide communication ultimately cause the environmental structure and availability and monitoring environment in the company structure (Chatterjee et al., 2021).

The experiences that consumers provide in exchange for performance with a platform cause social experiences that cause intra-organizational relationships between employers and contractors. For example, the relationship between the organization's platform and the customer is an unwritten contract that pays attention to it and creates a continuous and long-term relationship. Establishing and maintaining relationships in social business is a crucial requirement and a standard norm for any organization or company (Al-adwan & Kokash, 2019). The evolution of digitalization technology and reengineering in CRM and its implementation by trained employees will make the company stable (Ceccarini et al., 2022).

A compatible CRM represents and preserves customers, which makes them last longer and, as a result, the company's profitability. It is created by a scenario between employees and different organizations. By effectively using CRM training employees and including it in the organizational culture, organizations can be encouraged by technology to integrate the organizational culture and employees compatible with technology, resulting in more

customer loyalty (Kangu et al., 2017). Providing services through electronic technology is unavoidable, and employees should be trained in new methods for long-term relationships with customers (Al-Hazmi, 2021).

Direct and strong communication with customers is one of the success factors of a company (Milovanovic et al., 2016). Small businesses and startups are usually established by former employees. At first, the income level of these companies is low; they can increase their profitability by hiring a large number of people, increasing the firm and effective relationship with the customers, and performing better performance in marketing (Hajli & Lin, 2016). Trained employees can emphasize its practicality by introducing new values of the product to the customer. The high quality of these presentations by the employees depends on the speed and high quality of the service, which leads to customer loyalty (Yu et al., 2021).

A change in the organization's CRM strategy and the concentration of employees communicating with customers in various areas of marketing and support causes long-term relationships between the customer and the organization (Cierna & Sujova, 2022).

## 2.9. Customer Behavior

Various factors can affect customer behavior, including the quality of services, information and support, etc. (Razak et al., 2016). One of the main factors that play a role in customer behavior is product quality, which is one of the requirements of the technologies used, which are shown in the customer's targeted behavior (Ahani, Ab. Rahim, & Nilashi, 2017). One of the customer behaviors is the level of loyalty that is obtained based on their experiences using a product from a brand, even if there is a more reasonable choice. Many internal CRM procedures help to achieve the perfection of the organization, which is achieved by attracting and retaining customers (Bahari & Elayidom, 2015). The same and homogeneous products have a direct effect on maintaining customer loyalty and consumer behavior (Singh & Chauhan, 2018). Customer support, maintaining the privacy of customers, maintaining the quality of customer relationships, and delivering products and services have an impact on customer behavior, and ECRM provision has a positive effect on this behavior (Vaitone & Skackauskiene, 2020).

With the speed of progress in information technologies and the existence of changes in the diversity of consumers, the old and normal methods to attract customers are no longer effective. One of the factors of complexity in CRM is the changes in customer behavior, and therefore, creating a new pattern is inevitable (Abdi et al., 2020).

The neglect of customer behavior by company managers often results in the inability to meet consumer demands, leading to the loss of many long-standing customers (Herhausen et al., 2019). Relationships between customers and computers have a direct effect on ECRM (Mousavai, 2015). Therefore, it is necessary to attract new customers to establish strong and long-term relationships (Khanh et al., 2021).

Customers have digital behavior, and organizations should adapt themselves to this demeanor. This change in the manner of organizations requires their entry into electronic and digital industries. Digital startups are constantly updating themselves and developing and expanding. Companies should update their electronic and digital technology according to customer’s behavior to create the desired ECRM. According to the buyers' previous research about the product before buying it, the appearance, efficiency, and user-friendliness of the sites are desired by the customers (Raihan et al., 2005). The behavior of customers and the

needs of employees create a priority and urgency to establish ECRM in the company to meet the needs of consumers and customers (Bashir Bugaje, 2015). According to the change in consumer behavior in the digital era, CRM has been converted to ECRM, and companies are converted to ECRM by changing their structure. This issue in the international electronic business, which is based on the Internet, has caused the creation of Internet purchases and a change in customer behavior (Le Tan, 2017). Moreover, digital e-commerce is based on innovative behaviors, customer demands, and society's awareness in the digital era (Hermawati et al., 2020).

## 2.10. Market Requirements

The high demand by the customer has a negative effect on customer support services and causes ECRM acceptance to decrease (Harrigan et al., 2009). Customer preferences, types of markets, and potential market trends help organizations by analyzing the obtained data (Hariri et al., 2019). These organizations collect their data from interactions with customers and market needs (Giacomarra et al., 2019).

One of the most important factors in industries is customer orientation, and the long-term relationship with the customer is one of the main issues according to the needs of the market (Khan et al., 2020). In order for companies to remain in the minds of customers and stay for a long time, market needs and strategies taken for them are very important for branding the company (Alnsour & Tayeh, 2019).

By reducing costs and recognizing the needs of global markets, micro, small, and medium companies can market in global markets. In the marketing processes, to face the customer, corporations know the needs of the market for the implementation of ECRM (Guha et al., 2018). Still, there are few studies conducted in the field of CRM in different economies (Shastri et al., 2020).

One of the main advantages of companies competing in the market is innovation in understanding market needs (Rajapathirana & Hui, 2018). By introducing innovation in their products and services and measuring it, companies can recognize market needs (Migdadi, 2020). From this point of view, innovation in understanding market needs, including quick and effective responses to customers and shareholders, improves their ability to implement commercial processes and marketing methods (Mulyana et al., 2020). In order to facilitate marketing, innovation, and understanding of the needs of the market, it is possible to share knowledge (Herman et al., 2020).

In this connection, particular information technology can be used by companies as a platform for faster and cheaper communication (Liu & Huang, 2018). Innovation in marketing and services related to marketing in the global economy is for the purpose of profitability and maintaining relationships (Milan et al., 2018). Customization of relationships and improvement of service delivery to customers according to understanding the market requirement will reduce the cost of companies' audits (Harrigan et al., 2011). The more the

needs of customers and beneficiaries are facilitated, the more long-term relationships are formed with customers. Therefore, understanding the demands of customers and the needs of the market helps in this matter (Domi et al., 2020).

ECRM has been used in various organizations to improve the relationships with those customers who have less profitability in the direction of market needs (Marino & Presti, 2018). Consequently, to maintain the profitability of the company, the target markets of the customers are considered as the goals of the company (Gelhard & Von Delft, 2016). Creating a competitive advantage through ECRM helps marketing to identify customer and market needs and creates effective capabilities for employees and managers (Dewnarain et al., 2019; Gil-Gomez et al., 2020; Gholami et al., 2020).

## 2.11. Customer Satisfaction

One of the advantages of using ECRM is improving customer satisfaction, which is provided by information technology through the Internet (Oumar et al., 2017). Customer satisfaction leads to long-term relationships, which is possible digitally through ECRM (Jih, 2011; Raihan et al., 2005). One of the advantages of ECRM is customer loyalty and satisfaction, and consequently, more profit (Farhan et al., 2018). The satisfaction that is induced by the customer depends on direct communication with the customer, which can be profitable (Kotler & Armstrong, 2018). Customer satisfaction is directly related to customer retention (Pasape, 2022a; 2022b).

ECRM tools and procedures are for customer satisfaction, maintaining customer relationships, and improving the value of these relationships (Galvão et al., 2018; San-Martín et al., 2016). In developing or advanced countries, investments are made in line with customer satisfaction, and actions are taken to link ECRM and customer satisfaction (Mulyono et al., 2018; Mang'unyi et al., 2018). Improving the organizational culture towards accepting information technology, creating the necessary infrastructure in companies, and using ECRM will increase the efficiency of employees and customer satisfaction (Navimipour & Soltani, 2016). Among the results obtained from ECRM, it is possible to mention customer satisfaction, retention, and loyalty (Smith & Machova, 2021).

Increasing customer satisfaction and trust leads to customer retention and maintaining relationships with them (Ismail & Hussin, 2016). It is predicted that soon, customer satisfaction will be a substitute for profit, and it will be determined as one of the first and most important success factors of companies. This customer satisfaction is obtained by increasing the quality of the provision of services and products, and ECRM performance directly affects customer satisfaction (Heidemann et al., 2012). Therefore, customer satisfaction and loyalty are prerequisites for further progress in the quality of work. Customer satisfaction is obtained by fully understanding the needs of the market and customers, which results in organizational satisfaction (Rydell & Suler, 2021).

ECRM can create customer satisfaction and long-term relationships through information technology (Dahl, 2018). Empowerment in ECRM and marketing principles brings many advantages for organizations, including cost reduction and customer satisfaction (Harrigan et

al., 2020). One of the most important issues today is the direct relationship between customer experience and loyalty, which is one of the most basic and determining marketing issues because quality and good customer experience are directly related to customer satisfaction and loyalty (Eghbali et al., 2021).

According to a survey of small and medium companies, the existence of ECRM is necessary for a long-term relationship (Pohludka & Stverkova, 2019). One of the goals of marketing is to convince customers to buy products or services. With the development of information and communication through new technologies and organizing ECRM, the relationships between companies and customers are changing and converging while maintaining customer satisfaction (Lokesh et al., 2022).

## 2.12. Researches aligned with the results and achievements of the current research

Numerous studies have also demonstrated similar outcomes in alignment with the findings and accomplishments of the current research. These researches, conducted across various disciplines, have consistently validated the core principles and methodologies employed in the current study. They have corroborated the results and expanded upon them, providing additional depth and perspective. The consensus among these researches underscores the robustness of the current research's conclusions and its significant contribution to the existing body of knowledge. This alignment in findings also opens up promising avenues for future research and collaboration, further reinforcing the relevance and importance of the current study. Based on the above explanations, refer to the table 6:

Table 6-Researches aligned with the results and achievements of the current research

| No. | Author | Main Idea | Results | Aligned/ Unaligned |
|---|---|---|---|---|
| 1 | (Almajali, Al-Okaily, Barakat, Al-Zegaier, & Dahalin, 2022) | Technological Innovation & ECRM | CRM is integrated with technology, so technology is one of the main elements of ECRM | Aligned with H1 |
| | (Damabi, Firoozbakht, & Ahmadyan, 2018) | | ECRM has different dimensions such as employees, systems, advanced technology, and organizing procedures | |
| 2 | (Baha, 2023) | Technological Innovation & SCM | Digitalization of the supply chain in its first stage is effective in business development. | Aligned with H2 |
| | (Olutimehin, Ofodile, Ejibe, Odunaiya, & Soyombo, 2024) | | Commitment to continuous innovation, Proactive adaptation to new challenges, and Enhanced responsiveness and efficiency are the pivotal roles of technological innovations. | |
| 3 | (Lasyoud & Alsharari, 2017) | SCM & ECRM | Effective in improving the marketing process, and making supply chain management more effective | Aligned with H3 |
| | (Gencer, 2020) | | Improving the supply chain, analyzing data, and increasing satisfaction | |
| 4 | (Abdi, Hamidizadeh, & Gharache, 2020) | Technological Innovation & Business Management | Speed of progress in information technologies and the existence of changes | Aligned with H4 |
| | (Chatterjee, et al., 2021) | | Structure and availability and monitoring environment in the company structure | |

| | | | | |
|---|---|---|---|---|
| 5 | (Libai, et al., 2020) | Business Management & ECRM | Data collection, analysis, modeling, and creating an approach for sustainable and lifelong relationships | Aligned with H5 |
| | (Kamboj, Yadav, & Rahman, 2018) | | Review cases interactively and quickly | |
| 6 | (Alshraideh, Al-Lozi, & Alshurideh, 2017) | SCM & Technological Innovation & ECRM | Made more efficient to cause multiple purchases and orders and create a valuable mutual relationship from an economic point of view | Aligned with H6 |
| | (Chaudhuri, Chatterjee, Kraus, & Vrontis, 2021) | | To gain integrity and stability, especially in times of crisis and epidemics | |
| 7 | (Ghosh, Chatterjee, & Chaudhuri, 2020a) | Business Management & Technological Innovation & ECRM | Collect business information and data by considering information technology and complex technologies | Aligned with H7 |
| | (Chatterjee, Chaudhuri, Vrontis, Thrassou, & Ghosh, 2021) | | Collect the amount of information and data obtained with technology and at a high speed | |
| 8 | (Hizam-Hanafiah & Soomro, 2021) | Production development & Technological Innovation & ECRM | At the same time provides more valuable services and products | Aligned with H8 |
| | (Rydell & Suler, 2021) | | Determines the acceptance of innovative technologies and product development | |
| 9 | (Poita, Mosiichuk, Gurenko, & Perelygin, 2022) | Strategic Management & Technological Innovation & ECRM | Increase the volume of sales, and profitability, satisfy consumer demands | Aligned with H9 |
| | (Pozza, Goetz, & Sahut, 2018) | | New technologies, including operational CRM, analytical CRM, and collaborative CRM | |

Source: Author's own

## 2.12. Conclusion

Electronic Customer Relationship Management (ECRM) has become crucial for businesses to manage customer relationships in the digital age. Implementing ECRM can help organizations improve customer satisfaction, understand market requirements, and make informed decisions. By analyzing customer behavior and preferences, ECRM enables businesses to personalize their offerings and enhance the overall customer experience. Moreover, ECRM can facilitate strategic and supply chain management by providing valuable insights into customer needs and preferences (Ledro et al., 2022).

In the context of product development and innovation, ECRM can help businesses identify new opportunities and create products that meet market demands. By involving customers in the product development process, ECRM can ensure that new products are aligned with customer needs and preferences. Furthermore, ECRM can help businesses manage their employees more effectively by providing the necessary tools and information to engage with customers (Sher et al., 2021).

In conclusion, ECRM is a powerful tool for businesses to manage customer relationships, improve customer satisfaction, and gain a competitive advantage. Implementing ECRM requires a strategic approach focusing on customer needs and preferences. As the digital landscape evolves, ECRM will become increasingly important for businesses to succeed in the marketplace. The following references provide further insights into the role of ECRM in business management (Cartwright et al., 2021).

# Chapter 3
# Research Method

## 3.1. Introduction

Research is defined as a systematic and organized activity for specific problems that require a solution; in other words, research is a type of study, examination, and scientific research that is accurate and relies on systematic and organizational data and information in a difficult problem. The goal is to find an answer or a solution to that problem.

This chapter discusses the research method, including the structure of the methods, sources of information collection, planning and design, and the process of collecting and analyzing data. The chapter also covers the target population, the statistical sample of the research, and the method of sampling and determining its size. The tools and questionnaires used for data collection are provided. It is important to note that customers and consumers are constantly seeking suppliers who can offer them better products or services. In today's competitive market, meeting the needs and demands of customers before competitors is crucial for the success of any organization. Therefore, businesses strive to gain a competitive advantage by obtaining unique benefits and differentiating themselves.

One of the most popular methods to determine the level of satisfaction of needs and wants through goods and services provided by organizations is customer satisfaction measurement. Obtaining customer satisfaction provides an effective tool to control the overall performance of the organization. It helps the organization identify its weaknesses and eliminate them. It is possible to identify the advantages of the economic system according to the specific requirements of the time and conditions.

The required information is collected using various sources such as books, interviews, questionnaires, and related articles, and it is obtained using a scientific structure appropriate to the questions raised. In the following, the obtained results of the analysis and the results of different simulation executions are compared with each other for different prediction policies and attention to the applied inventory control policies.

## 3.2. Introduction to the case study method

The behavior of society and customers has become a determining factor for behavior and social reality, which directly affects qualitative research. Tests on hypotheses considered in problems and development on them are used in quantitative research, which is the opposite of qualitative research. In qualitative research, the focus is on the essence of the research itself and not on the number of its features.

A case study allows the researcher to easily investigate the problem in research, understand and explain and clarify it, and create a comprehensive view of it. In this way, a case study includes a part of a larger collection or similar collections over time or in a specific time frame (Chatterjee et al., 2021).

This case study deals with the issue of companies and organizations having the best products and services accepted by customers and individuals, and according to the customers' needs, they should provide the best. Management under the title of customer experience management can, by transferring these experiences to organizations, create competitive and advantageous solutions that ultimately improve the performance of companies and lead organizations to new knowledge.

## 3.3. Framework of study

An overall view for a better understanding of the working framework should be noted below in Figure 7:

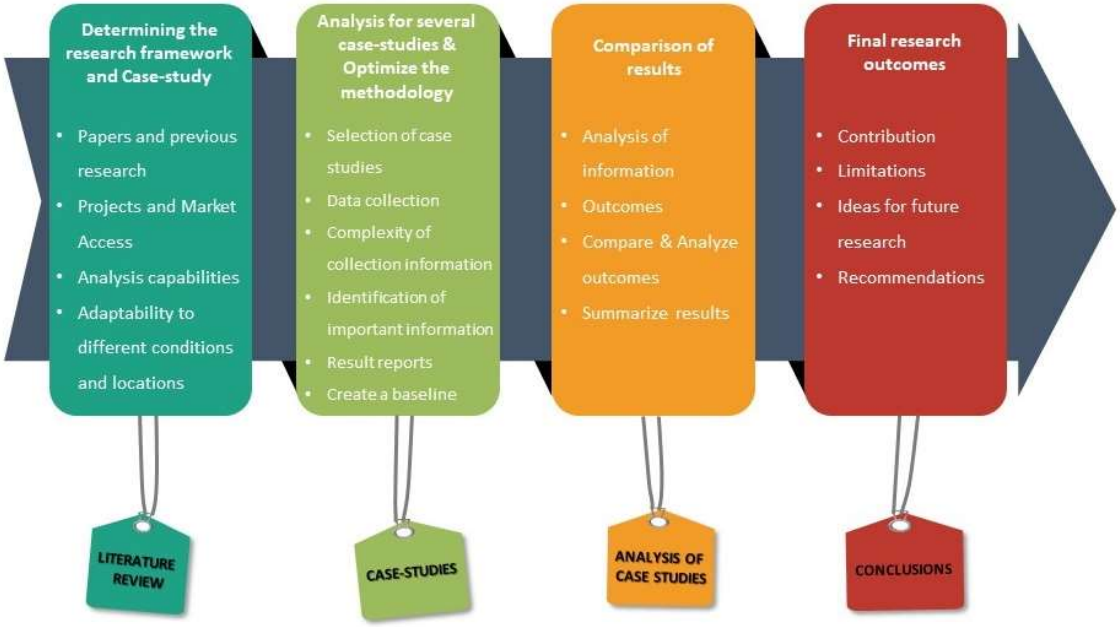



Figure 7- Framework for a better understanding of the study
Source: Author's own

## 3.4. Stage of research

First stage: Research field, Hypotheses, model, objectives, methodology

Second stage: Literature Review, background or previous observations

Third stage: (Case-study projects: Plan, Design, Collect, Analyze) Reasons for using the research method, steps and details, Formulate hypotheses

Fourth stage: Collect data, test the hypotheses, and Information model

Fifth stage: Analyze results, Conclusion about hypotheses, theoretical and practical applications

## 3.5. Types of research

The types of this research are:

- According to application: Strategic basic research, Experimental development
- According to objectives: Descriptive research, Exploratory research

- According to strategies: Mixed strategies (Quantitative and Qualitative strategies)- Concurrent mixed methods.

### 3.5.1. Strategic basic research

Mixed strategies that include qualitative and quantitative strategies are considered. Combined Concurrent and Transformative methods are used for research on the subject.

### 3.5.2. Experimental development

Through modern knowledge and previous experiences, the production of commodities or the performance of services are improved, and new products and services are provided, which is an ethical process.

Regarding this topic, the goal is to provide results that can be presented independently or presented in the market, and it is done in the case that it is not sure of sufficient resources or time, which can be done with planning, budgeting, and time scheduling. One of its stages is Research and Development (R&D), which is achieved by developing software, technology, methods, innovation, method innovation, and fundamental improvements.

### 3.5.3. Descriptive research

It usually describes the structure of an organization or project, product, service, system, etc. In this type of research, there is no control over the variables, which are about why and how the problems have arisen. This type of research has a direct relationship with observational studies, which are investigated by researching a sample of the researched community.

A survey is one of the ways in this type of research in which the objectives and design of questions and the type of questions are important. The case study method is one of the group or individual study methods that expands by proposing hypotheses and investigating phenomena (Mostly quantitative) (Yin, 2014).

### 3.5.4. Exploratory research

Research is conducted on a specific topic or a specific study topic that there is little information about. The purpose of research is to provide answers to existing problems by identifying general principles and data related to a particular phenomenon or question. Data

collection can be done through questionnaires, surveys, and interviews. With this information, it is possible to determine the source of the pattern for framing. Observations and data such as tables, samples, samplings, statistics, etc., from different points of view, are specified (Mostly qualitative) (Mark et al., 2019).

### 3.5.5. Quantitative research

Conducting an investigation on the problems of research through experimental research and surveys and the tools of graphs, statistics, numbers, etc. In this method, numbers show the degree of relationship between two or more variables. By quantifying the data, it is possible to express the problem.

Quantitative research is investigated by mathematical, computational, and statistical methods. Data are obtained through questionnaires, statistical research, and reports and are tested with different mathematical models and the relationship between different variables is studied. Their causes and effects are investigated, and relationships are tested (John et al., 2018).

### 3.5.6. Qualitative research

Investigating the problems of research and the structure of those problems through tools and exploring events and processes, discovering the understanding of the nature of a phenomenon and research, events and stories and experiences, theories and views of participants and members and people involved. Those problems are mainly caused by non-numerical aspects (Denzin & Lincoln, 2011).

For a better understanding of the quantitative studies that have various limitations, or to add more details to the research, to discover other different perspectives from the sample of other societies, research that is a combination of quantitative and qualitative, and phenomena with many complications. The quantitative method is used.

**Comparison: Qualitative - Quantitative Research**

Table 7- Qualitative Vs. Quantitative methods

| Description | Qualitative | Quantitative |
|---|---|---|
| Framework | Explanation of the phenomena | Research related to hypotheses, causes and factors |
| Objective | Describe and Explain | Numerical |
| Type of Data | Textual (Images, Videos, Internet-base) | Numerical (Tables, statistics, charts) |
| Question format | Open | Close |
| Statistical Society | Small & Chosen | Large & Random |
| Design method | Exploratory, Inductive inference or "Bottom-up, Stable | Establish the Correctness, Deductive inference or "Top-down", Flexible |
| Variable | The whole study, not-variable | Independent, dependent, external |
| Subject | The subject has priority, Open descriptive topics | The objective has priority, Controlled subjects |

Source: Author's own

**Survey: Information collection system**

A questionnaire (available in the Appendix) is used as one of the survey tools in which the list of goals is analyzed. All aspects of the goals are included in the survey, and in this case, time and space limitations are also considered, and the final report is the result.

Its steps are as follows: First, the objectives of the study are targeted, and interviews and necessary investigations are conducted with experts and members of the statistical community. The final results are the basis of the decision-making framework. Data analysis is done, and the final report determines the results.

There are various methods for this, such as telephone interviews, face-to-face interviews, internet surveys, email surveys, mobile application surveys, etc. In these types, by clicking on a link and filling in the attachment file in the email, they can complete the steps.

**Simple random sampling:** The subsequent formula can be employed to determine the sample size (Daniel & Cross, 2013):

$$n = \frac{Z^2 \hat{P}(1-\hat{P})}{E^2} \quad (8)$$

$n$ is the sample size

$Z$ is the z-value

$\hat{P}$ is the population proportion

$E$ is the margin of error

Then,

Confidence level: 95% (z-value is 1.96)

Population proportion: 50% (0.5)

The margin of error: 5% (0.05)

This calculation results in a sample size of approximately 385.

## 3.6. Subject of research

A Model for Estimating the Success of Electronic Customer Relationship Management (ECRM) Systems In Industry Management.

## 3.7. Location of researches

1. Project A: Project in the Oil industry

   The project is valued at €292 million and operates under an Engineering, Procurement, and Construction (EPC) contract. The project's duration is set for 38 months and is currently ongoing. The workforce comprises over 2000 personnel responsible for designing, procuring, and constructing a facility.

2. Project B: Project in the Transport sector

   This project's value is approximately $4000 million and operates under an Engineering, Procurement, and Construction (EPC) contract. The project's duration is set for 48 months and is currently ongoing. The workforce comprises over 5000 personnel responsible for designing, procuring, and constructing a facility with a line capacity of 45,000 passengers per hour per direction.

## 3.8. Research resources (Data source)

After the basic design stage, which includes knowing and choosing the subject, case studies, shortcomings, hypotheses, and goals, the next step is to move on to the detailed design phase. At this stage, the method, type, and selection of information collection are examined.

These affairs are carried out at different levels: organizational management (public and private), executive and operational positions, and engineering and analytical levels. The information and data obtained have been collected through the following methods: documents and data of projects, and specialized interviews with people at different organizational levels.

In the last phase of the projects, whose final stages are being carried out, this information is obtained according to the above methods to be examined first-hand from a credit point of view, and these people and the information obtained in the implementation phase of the project are a completely transparent reflection of be the behavioral and practical performance of the project.

### 3.8.1. Project Documentation

These documents, which are in the form of project performance reports, scheduling reports, Work Breakdown Structure (WBS), executive reports, project planning, and control reports, are related to each stage and each phase of the project, from the basic stage- design- Implementation- and start-up stage.

These documents have been collected in two main stages:

- Officially and systematically, through project software and servers, and attachments with official letters from the employer and main organizations.
- Informally through routine emails, intra-departmental calculations, informal meetings between project people, etc.

### 3.8.2. Interviews

Surveys have been considered for interviews with main managers, mid-level managers of organizations, and experts and specialists. Because there are many topics and means to be investigated, two types of methods have been used for these works:

- Qualitative: The questions in this section were asked based on two types of questions, "whether" and "when" (as they were previously presented in the explanatory steps). The main steps and the determined goals were defined as a process according to their timing period.

- Quantitative: According to the numbers and information extracted from the documents mentioned above, the problems were numerically converted and scored.

The procedure is as follows:

- All activities were segregated
- Activities were prioritized
- The development schedule of each activity was planned
- The characteristics of each activity were separated

By conducting qualitative and quantitative interviews, the research aimed to comprehensively understand the challenges and opportunities related to the topic under investigation.

According to the above explanations, qualitative interviews were conducted:

1. For not completing each relevant step, have there been any consequences for completing the project?
2. If yes, what were the consequences and why?

An example of this structure and composition is described in Table 8:

Table 8- A sample for Cause and Delay Table for an EPC project

| Discipline | Plan Issue Date | Description | Cause of Delay |
|---|---|---|---|
| Telecom Engineering | 2023-03-05 | Radio & Radar Systems | Failure to complete the main building |
| Electrical Engineering | 2023-01-22 | Transformer | Delay in buying connection cables |
| Instrument and Control Engineering | 2023-02-22 | Temperature Transmitters | Delay in confirming documents |
| Process Engineering | 2023-03-15 | Auxiliary System | Failure of the supplier to deliver on time |
| Piping Engineering | 2022-10-20 | Piping for Oil and Gas Separator | Waiting for confirmation of documents |
| Safety | 2022-11-10 | Safety Valves | Lack of main valve installation |
| HVAC Engineering | 2023-03-14 | Main HVAC Equipment | Failure to provide installation infrastructure on time |
| Civil Engineering | 2022-08-19 | Main Control Building with Access Road | Delay of transport machines |
| Structural Engineering | 2023-01-20 | Structural For Fire Water Pump Shelter | Not buying enough materials |
| Architecture | 2023-03-20 | Architectural Detail for Substation | Mistake in the design of the map |

Source: Author's own

The most important factors involved in these projects are scheduling and cost. Hence, the factors that are directly related to these cases are a priority. Consequently, the interview is effective in line with these factors.

After conducting several interviews, a general outline of the issues and their plan and development is formed. Next, it is necessary to plan and find the reasons for the emergence of these problems. Concerns arise across various fields and executive departments, leading to diverse analyses of distinct subjects being conducted and summarized.

The projects considered for this research are in different industries, such as oil and gas, rail industries, metro, and urban train industries, which can be good examples of the problems in industrial projects. It should be noted that these problems are only specific to these projects, and every other industrial project has its own unique set of problems. These problems are classified and included in various categories. These problems have been analyzed in the project management of each project. Interviews are ranked in order of priority and necessity and then based on their effectiveness in the project time schedule and budget (Table 8).

These categories are specified as follows:

- Lack of coordination between different disciplines
- Lack of coherent and single interface management between disciplines
- Lack of systematic communication between different technicians during installation and implementation
- Lack of coordination between the commercial and financial divisions to provide timely budgeting based on the requested time
- The non-commitment of some experts to the project schedule in various commercial and financial divisions, engineering, implementation, installation, commissioning, and quality control.
- Misunderstanding of scheduling and budgeting
- Inadequate training of some experts and technicians

Survey and interview methods are used:

Table 9- Survey and Interview methods for EPC projects

| TYPE | DIFFICULTIES | USAGE |
|---|---|---|
| Telephone | - Repeated follow-ups to access the person<br>- Lack of access to the person's direct phone number<br>- Difficult to understand the content of the interview | - Fast response<br>- Low cost<br>- Short response time |
| Face-to-Face | - Time-consuming for both parties<br>- The problem of physical access to the person<br>- The possibility of answering incorrectly<br>- Misdirection of the interviewer | - Confidence in accountability<br>- Diagnosis of the health of an expert<br>- Challenge in accountability<br>- Understanding practical points in one's field of expertise |
| Mail | - Repeated emails and reminders<br>- Long response time<br>- Uncertainty in the person responsible, especially at managerial levels | - Low cost<br>- Response in a short time<br>- No need to visit in person |
| Internet, Online (Skype,…) | - Definite probability of repeated contact<br>- Internet quality of base and destination<br>- Coordinating meeting time | - No need for physical presence<br>- Understanding both sides<br>- Discussion about the nature of the problem<br>- Similar to the presence of face-to-face |

Source: Author's own

## 3.9. Introduction of variables and their operational definitions

### 3.9.1. Variance-based approach or Partial Least Squares (VB-PLS)

According to subsection 1.4.1, chapter 1, Partial Least Square is a method for structural equation modeling that examines the relationships between latent and observable variables. It usually includes a small study sample, and it is appropriate for prediction.

The fit indices are used in predicting dependent variables such as Goodness of Fit (GOF). For the measurable model, predictions can be made through these indicators. Also, for the structural model, the predicted the effect of external variables on internal variables. Various software, including Smart-PLS, Warp PLS, and Visual PLS, can be used for this purpose.

### 3.9.2. Sample size in PLS partial least squares method

In this type of method, because there is no need for a very large sample size, the use of large sample sizes will face the problem of stability. However, by examining larger samples, the

results obtained from PLS can be more assured because the smaller the samples, the weaker the results and cannot be generalized. According to the above explanations, if the sample size is increasing, the average absolute error rate also decreases, so in such cases, the method based on covariance is used.

The minimum required sample can be determined in two ways: the maximum number of indicators that can be identified in the measurement samples or the maximum number of indicators that contribute to a variable.

### 3.9.3. Reflective measurement models (Reflective) and combined models (Formative)

The reflective and formative indices are the difference between PLS and covariance methods, which do not combine these two methods.

- Reflective: In interviews, surveys, etc., attitudes, expert opinions, traits, etc., are the same latent variables. The existence of these variables is expressed and determined by other variables. In this type of model, jet arrows are shown from the latent variables to the observed variables, which means that the measurements shown in these observed variables are a reflection of the changes in those latent variables. Therefore, the correlation between the observed variables is positive. These latent variables are also called structural variables.
- Formative: The reason for the emergence of those latent variables is known as Formative, which causes the emergence of latent variables. In this type of model, the correlation between variables can be negative, zero, or positive. For example, the latent variable of failure by the contractor to provide a part was created by a combination of factors, including delays in sending engineering documents, non-arrival of raw materials, and ineffectiveness of the relevant expert. That is, these factors will cause and affect this problem. In this type of model, the direction of the arrow is shown from the side of the observed variables to the latent variables; that is, any changes in the observed variables will affect the latent variables.

The model shown below in Figure 8, is an example of the relationship between these variables (Hair Jr. et al., 2021):

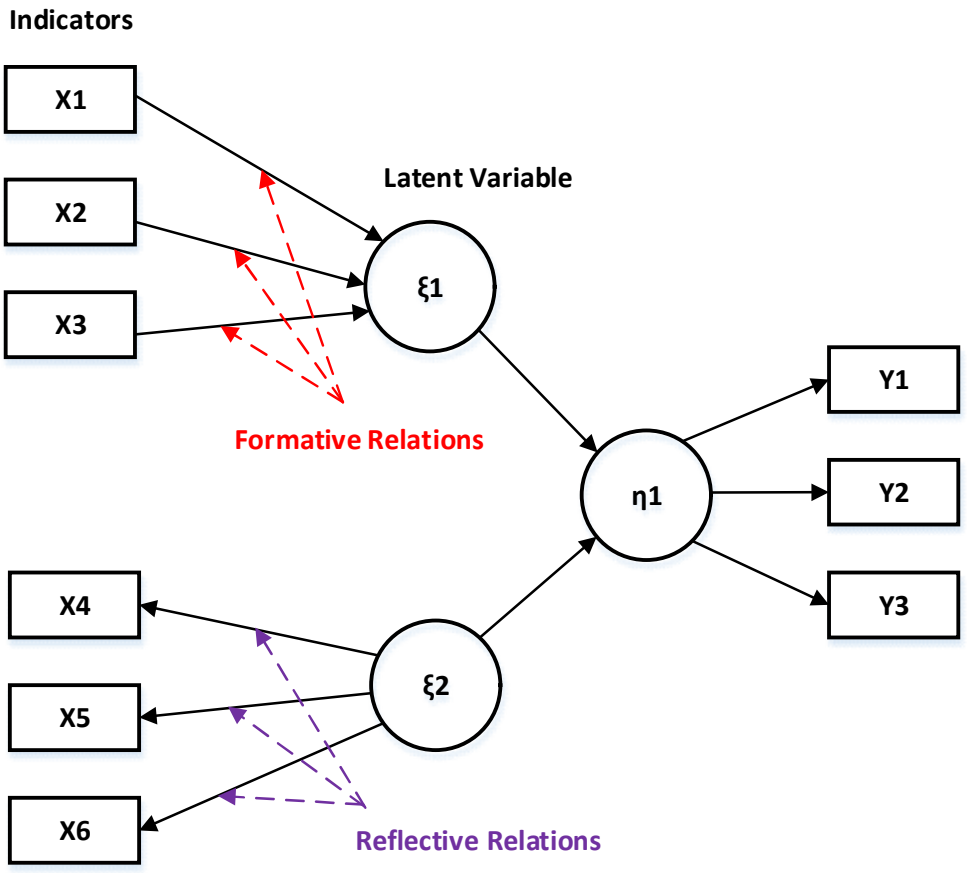



Figure 8- An example of Reflective and Formative differences
Source: Hair Jr. et al. (2021)

Variables shown as circles are not directly measured (η1, ξ1, ξ2)

Variables shown as rectangles: directly measured, known as observed variables (X1…X6, Y1…Y3); (More information is mentioned in part 1.4.1).

### 3.9.4. Inner Model and Outer Model

Two models, the Inner model (also called the structural model) and the Outer model (also called the measurement model), are tested in the PLS method, which is as follows (Hair, Hult, Ringle, & Sarstedt, 2022):

External model: It measures the relationships between latent variables and their indicators through reflective and formative methods.

Internal model: shows the relationships that exist between latent variables (Hair Jr. et al., 2021).

### 3.9.5. Assessment of the Measurement Models

Three steps of examining PLS and covariance-based models:

- Assessment of the outer model: Reliability and Validity
- Assessment of the internal model
- Assessment of the PLS model

**Assessment of the internal model (structural model):**

There is only one type of structural model in the path model that specifies the relationships and effects between characters and variables.

**Assessment of the outer model (measurement model):**

According to the information in Table 10, the measurement model is as follows:

Table 10- Evaluation criteria of the measurement model (outer model)

| Type of Model | Feature | Index | | Description |
|---|---|---|---|---|
| Reflective measurement model | Checking the one-dimensionality of the model | From the correlation matrix with the variables, there is a big difference between the first and second eigenvalues obtained. | | |
| | Reliability | Observed variables | | The absolute value of the factor load of each of the observed variables with the latent variable is at least 0.7 |
| | | Cronbach's alpha | | The acceptable value and criterion is at least 0.7 |
| | | composite reliability | | To check the internal consistency, which should not be less than 0.6 |
| | Validity | Convergent Validity | | AVE is at least 0.5 |
| | | Discriminant validity | Cross Loadings | The factor loading of each indicator on the latent variable related to itself is at least 0.1 higher than the factor loading of that indicator on other latent variables. |
| | | | (Fornell & Larcker, 1981) | The root AVE of each latent variable must be greater than the correlation of that variable with other latent variables. |

| | | | | |
|---|---|---|---|---|
| Formative measurement model | Validity | Latent variable level | Meaningful narrative | The relationship between the composite observed variable and other latent variables in the path model based on previous research should be strong and significant. |
| | | | External validity | The composite observed variable should explain a large part of the variance of an alternative reflective observed variable of the main construct. |
| | | Observed variable level | Significance of weights | The estimated weights of each of the combined observed variables must be significant. |
| | | | Multicollinearity | VIF greater than 1 indicates multicollinearity and values greater than 10 indicate critical multicollinearity. |

Source: Hair Jr. et al. (2021)

**Assessment of the PLS model**

In contrast to the covariance method, there is no method in PLS to measure Goodness of Fit (GoF) in the whole model, in this regard, Zhao & Li (2022) and Tenenhaus, Amato, and Vinzi (2004) introduced an index called Goodness of Fit (GoF) in this method, $R^2$ and average communality are obtained from the following formula.

$$\text{GOF} = \sqrt{\text{average (Communality)} \times \text{average } (R^2)} \quad (9)$$

Since in partial least squares, the value of Commonality is equal to AVE (Chechile & Barch, 2022), provided the following formula:

$$\text{GOF} = \sqrt{\text{average (AVE)} \times \text{average } (R^2)} \quad (10)$$

Table 3 describes the PLS-SEM model according to CFA (Cheung & Rensvold, 2002; Chechile & Barch, 2022; Henseler & Sarstedt, 2013):

It is discussed whether the tested model was successful in predicting the latent variables or not. According to the main question and hypothesis of the research and the obtained data, each researcher should choose one of the above methods. According to the above explanations, five important factors are as follows: variables, measurement, scale, coding, and data distribution.

### 3.9.6. Validity and Reliability of the questionnaire

Objectives, questions, and hypotheses play a decisive role in the questionnaire. Studying researches and questionnaires similar to this research are very helpful. First, the initial sample of the questionnaire was prepared, which includes experience, and this questionnaire was tested. This questionnaire can be tested by knowledgeable people, experts, and researchers. The usual method that is used is to ask those experts to provide their own opinions related to this questionnaire.

According to the statistical context and the mentioned projects, questionnaires are prepared, which are distributed among those people. The results obtained from the collection of these questionnaires can include whether the framework and type of questions are suitable, whether the respondents were able to have a correct understanding of the topics, and whether the sample community under study can make a correct connection between create questions and problem statements. From this summary, the results of these questionnaires are examined by statistical methods and software, one of the most famous of which is Cronbach's alpha, which is used to check reliability.

**Validity:** For validity, it can be said to what extent the desired goals can be measured, that is, whether the measurements can measure the desired characteristics. Therefore, a questionnaire is suitable and can include all the desired subjects; otherwise, if some of the subjects are not in the questionnaire, that questionnaire does not have proper validity, and it reduces or destroys the validity of the research.

The method of checking this validity is as follows:

- The availability and accessibility of sources, such as documents or expert personnel, and the records of all operations in various departments are ensured.
- The questionnaire questions are designed based on objectives, hypotheses, questions, and problems.
- The type and questioning of surveys are developed with the help of experts and specialists and their relevant experiences to improve the credibility of the tool.

- Sample questions and surveys are provided to experts, sub-specialists, and beneficiaries as a preliminary sample.
- Finally, any mistakes are corrected to prepare the final version of the questionnaire.

**Reliability:** Reliability in research means that if the same conditions are repeated, these measurement tools will provide the same results. That is, if the time is shortened, the test is conducted in the sample community, and the test is repeated, how close can the results be to each other? According to the explanations, the results obtained between different types of tests between groups and, at the same time, how much correlation is there between these results. Therefore, this correlation can be called the reliability coefficient, which ranges between 0 and 1 (Hair Jr. et al., 2021).

The meaning of the number zero is that there is no reliability, and the number 1 indicates complete reliability. This number 1 is almost non-existent, and if we reach the number 1 in reliability, we should doubt the result.

There are different methods to calculate the reliability coefficient:

- The test can be restarted from the beginning, or specific steps of the test can be repeated.
- Equivalence is a method that can be used to change sub-hypotheses by changing alternate hypotheses and performing parallel testing methods such as textual, stylistic, etc.
- Split-half test method to investigate the direct effect of different samples. By dividing the questions into two parts and scoring a single number.
- Kuder-Richardson's method examines the questions using the right or wrong method.
- Cronbach Alpha method, which is not a type of test, and the reliability measurement method is the test score (the method used in this research).

## 3.10. Case-study achievement

There are various processes in the projects of this research, including scheduling, costs, and organizing various related departments. These sections include supply chain, product development, continuous innovation in used technologies, work management, decision-

making, and used strategies. All the variables and factors that were studied during the project process will be explained later. These variables are of two types: dependent variables and independent variables.

Dependent variables have characteristics that make them affect the project. Independent variables, as their name implies, are separate concepts such as time, cost, and uniformity of the project. In order to investigate the dependent variables, a sample project was first studied as a Pilot or Prototype. For this purpose, it is necessary to fully understand the environment of the project being studied and the relationships between the project's departments, to create an initial experimental study sample (sampling and initial understanding), and to collect all the required related information and data. It is necessary to specify the purpose, hypotheses and issues involved in the project to know the delays and the consequences of deficiencies before collecting and classifying the information of the project.

Adequate knowledge of the project environment, knowledge and understanding of the evidence that is effective in the work process, understanding and use of previous experiences, and even knowledge of opposing factors and conflicting evidence are also necessary. Examination of sample reports, documents, records of causes and effects, and project progress reports make it possible to make the necessary interpretations using experience. Therefore, having direct involvement and being an integral part of the project is one of the main and key points. In this case, at each stage of the project, the corresponding test or process report can be directly understood and collected so that it can be repeated in the next project and process.

One of the important factors is that before starting the study, it is essential to establish an agreement with the people, experts, responsible people, and subordinates to ensure their full cooperation and complete honesty. Therefore, direct communication with the people in the community of the study sample (project) is one of the important factors related to these communications.

## 3.11. The pilot case-study project

All stages of a project, which include preliminary studies, basic studies, estimates, completion of detail design, construction, testing, implementation, and commissioning, should be taken into consideration. Therefore, it is important to be able to distinguish each of these stages in

each project. Planning, scheduling, budgeting, recognizing risks, the ability to build and operate, and even the type of transportation in each project differ. In complex projects, there are many variables; for this purpose, an experimental study sample is used, which does not need to use all the variables of more complex projects.

The projects mentioned in section 3.7 are considered study subjects, the reasons for which are as follows:

- The activity of the researcher in all these projects in the engineering and design department as an engineering lead
- Concurrence of work history and participation in the process of current projects, participation in meetings as an engineering lead
- Direct access to project documents, project organizational personnel, supply sources, design and implementation process
- The stability of the projects due to relatively suitable financing of these projects
- Carrying out projects by strong and experienced companies
- Implementation of EPC methods and high level of implementation and installation of projects
- Creating the structural and organizational similarity of the projects, which creates the ability to generalize in the same way in these projects
- Involvement of the same people in all these projects over several years due to the matrix organizational chart of the companies involved in the projects.

As an overview of these projects, the companies involved in these projects include government companies as employers, private companies as main contractors and second-hand contractors, and private companies as consulting companies for employers. The source of funding for these projects is provided by the same state companies from the state-national budget, but the process of providing credit and payments is divided slowly at different levels of the project due to the existence of a lot of administrative bureaucracy.

In general, projects in companies are divided into commercial, financial, technical, and implementation sections. The place of installation and delivery of services and products are in the current location of the projects. Right now, due to problems in all these projects, in terms of scheduling, they are behind the initial schedule of the projects, and financially, the private companies have not received a single phase of their latest invoices. However, projects

are being implemented in all regions without exception. All projects are done in a phased manner; that is, in rail and metro projects, the projects are completed and launched station by station. In oil projects, refinery products are produced phase by phase, and in power plant projects, equipment is installed in stages.

Therefore, the study and collection of information and data can be generalized and developed in the next phases of each project. This issue can reduce the possibility of problems in the next phases.

## 3.12. Variables

Due to the existence of similar problems in the project process, the information obtained from interviews, surveys, project documents, etc., are divided into two quantitative and qualitative groups, and the data analysis is carried out in the research process, and preliminary studies are also done.

For qualitative analysis, a checklist of problems that exist in the project process is prepared. In this checklist, the existing problems and the parts to be studied are included. In interviews with people and experts working in the same areas, these problems are raised, and their expert opinions are received. According to the problems mentioned in the 7 clauses in section 3.8.2, in the relevant parts, the outputs obtained in the quantitative analysis are also updated. The checklist is as follows:

Table 11- An example of Checklist for Details of Problems in EPC projects

| Details of Problems | Telecom Division | Electrical Division | I&C Division | Process Division | Piping Division | Safety Division | HVAC Division | Civil Division | Structural Division | Architecture Division |
|---|---|---|---|---|---|---|---|---|---|---|
| Failure to execute the correct sequence of work and the occurrence of repeated work | | | | | | | | ✓ | | ✓ |
| Changing the contracting strategy approved by the project | | | | ✓ | ✓ | ✓ | | | | |
| Changing purchase characteristics (reducing the size of pipes and meters...) | ✓ | ✓ | ✓ | | | | ✓ | | | |
| The limitation of foreign exchange resources of the employer abroad | ✓ | ✓ | ✓ | | | | | | | |
| Overdesign in the employer's tender documents | | ✓ | ✓ | | | | ✓ | | ✓ | |
| Pressure from the employer to change the work priorities of the workshop | | | | | | | | ✓ | ✓ | ✓ |
| Non-acceptance of the offer to receive foreign currency advance payment by the employer | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | |
| Late start of execution operations | | | | | ✓ | | | ✓ | ✓ | |
| The reduction of the interface between civil sector one and piping, due to the handing over of civil executive operations | | | | | ✓ | | | ✓ | ✓ | |
| Increase in the global price of raw materials such as iron | ✓ | ✓ | ✓ | | ✓ | | ✓ | | ✓ | |
| The claim of suppliers to increase the price | ✓ | ✓ | ✓ | | | | ✓ | | | |
| The start of the project is not related to the receipt of advance payment | ✓ | | | ✓ | | | | | | ✓ |
| Changing the planned route in the initial design | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | |
| There are obstacles in the Culvert route to transfer surface water to the sea | | | | | ✓ | | | ✓ | | |
| Unforeseen changes in the preferential stage | | | ✓ | | | ✓ | | ✓ | | |
| Stopping activities related to displaced people | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | |
| Increasing design time | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Increasing the direct costs of the project | | | | | | ✓ | ✓ | ✓ | | ✓ |
| Project time increase | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Failure to complete the work with the contract price | | ✓ | | | ✓ | ✓ | | ✓ | ✓ | |

Source: Author's own

These categories are specified as follows:

- A: Lack of coordination between different disciplines
- B: Lack of coherent and single interface management between disciplines
- C: Lack of systematic communication between different technicians during installation and implementation

- D: Lack of coordination between the commercial and financial divisions to provide timely budgeting based on the requested time
- E: The non-commitment of some experts to the project schedule in various commercial and financial divisions, engineering, implementation, installation, commissioning, and quality control.
- F: Misunderstanding of scheduling and budgeting
- G: Inadequate training of some experts and technicians

A to G: Problem Category
Each Problem: $i$
The total impact of $i$: $I$
Project Time Schedule: $T$
Budget: $B$

$$I_T = \sum_1^n i_A + \cdots + \sum_1^n i_G \quad (11)$$

$$I_B = \sum_1^n i_A + \cdots + \sum_1^n i_G \quad (12)$$

Qualitative research is conducted to develop it for quantitative analysis. Therefore, qualitative research is done numerically, for which a computer is used. In qualitative analysis, the comparison method can analyze and group evidence and experiences and specify hypotheses. Therefore, they focus on finding similarities and differences, processes and patterns used in the project. The strategies that are used for the analysis of the hypotheses lead to the consideration of case studies. Considering these case studies, the analysis plan, functional planning, and proposed solutions can be organized. For this purpose, a working framework and a draft are prepared. Initial predictions are reviewed by variances and compared with evidence. This process is repeated until the results are satisfactory (satisfaction will be explained later). But in general, after the interviews and polls, if it is clear that all the opinions are the same about the issues, satisfaction has been achieved. One of the key points in this type of research is identifying changes and problems over time in projects, where experience is very important. Therefore, identifying dependent variables in processes, designs, and implementation is among the main fields.

## 3.13. Data Programming

After collecting information and data, one of the key steps in development and analysis is programming and coding. For this issue, qualitative research is divided into different categories. In information management, groupings are done, and the coding process is done. After conducting interviews, surveys, manuscripts, and reports, formulation, and relationships between elements are prepared. According to section 3.8, the obtained information is classified.

## 3.14. Time Scheduling and Work Structure

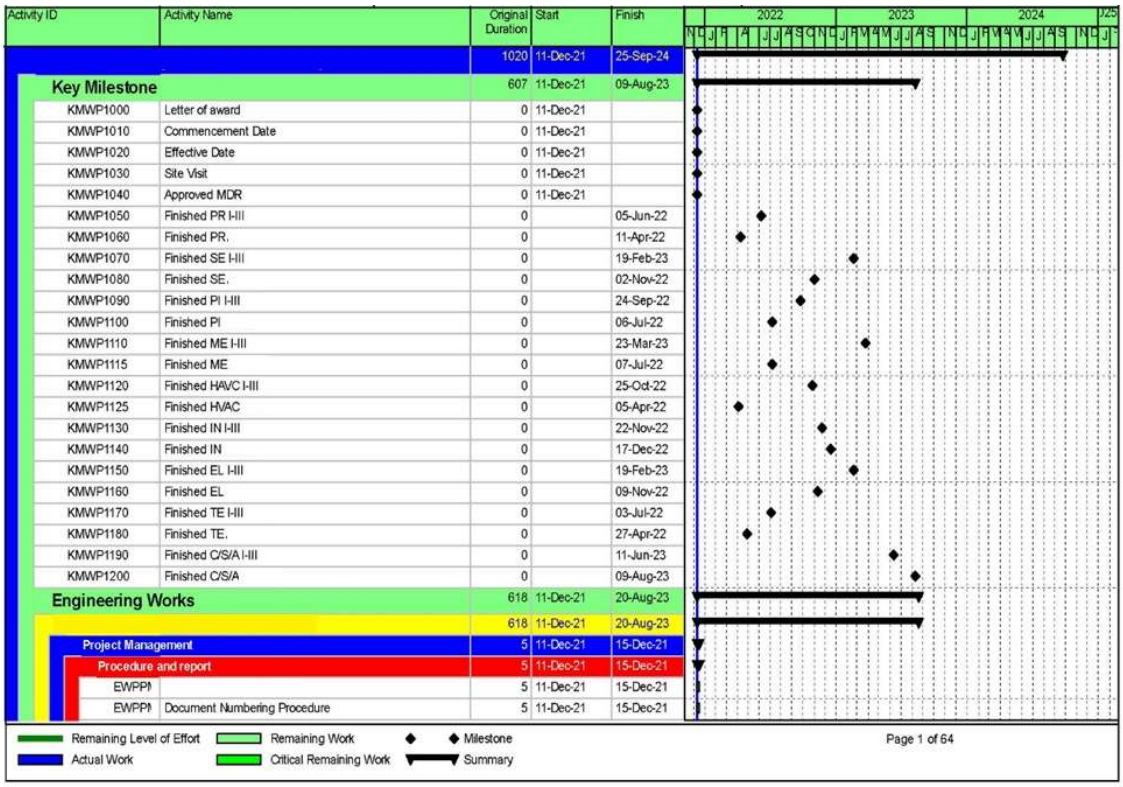
One of the software used in projects to organize, review, estimate, and view the planning and scheduling process is Microsoft Project (P6) software, which has been used in companies and these projects as well. From the graphs and reports obtained from them, different results can be obtained, some of which indicate delays and stability problems in the project. Project control experts procure these documents, which are then forwarded to the project manager, constituting one of the main documents for projects. Hence, the activities, the results obtained, and the review of the processes cause real improvement in these projects. Consequently, one of these separations of activities is the work breakdown structure. In different and consecutive periods in a project, activities and progress are defined, and at the end of each period, conclusions and target points are determined that the specified goal and activity have been reached within the specified time. For each activity, a procedure and a period of time are determined, which are followed with the expected target points. Therefore, due to the problems of performing each activity, the time setting does not meet the previously specified deadline. This means that for each activity, a total time is predicted at first, and then it is divided into smaller periods in terms of work and time. This procedure is followed, and this process is used for all processes in general. The project is characterized by its generality, as it typically involves the initial identification of departments followed by the identification of activities within each department, and then the activities of each department are separated in more detail and then according to time and dependence. The activities are defined together, the target points, the order of each activity, and the combinations.

In the Work Breakdown Structure (WBS), each individual activity has a time frame and a target date. Based on the research and analysis of each activity, the categorization and classification of activities and structures are obtained, and according to the technology and the experts in the project, the time frames for each activity are determined. From the analysis of the main documents of the project and previous and similar experiences, the type of activities and the overlapping period between the activities are determined, and the degree of correlation and dependence of each activity and time is obtained.

An example of WBS in a project in the oil industry is shown in Figure 9:

| No. | ACTIVITIES |
|---|---|
| **O** | **Overall** |
| 1 | Commencement Date |
| 2 | Approved MDR |
| 3 | General Arangement Approval |
| 4 | Site Visit |
| **5** | **Engineering Works** |
| 5.1 | Surveys |
| 5.2 | MTO |
| 5.3 | DataSheets |
| 5.4 | Calculation |
| 5.5 | List & Report |
| 5.6 | Drawing, Diagram and Layout |
| 5.7 | Schedule |
| 5.8 | Material Requisition |
| 5.9 | Material Take Off |
| 5.10 | Technical Bid Evaluation |
| **6** | **Procurement of Main Equipment and Main** |
| 6.1 | Pipe And Piping Components |
| 6.2 | Piping Valve |
| 6.3 | Strainer |
| 6.4 | Insulating Joint |
| 6.5 | Power Transformer |
| 6.6 | LV Switchgear |
| 6.7 | Power Cables (Instrumention , Electrical) |
| 6.8 | Instruments (PT,FT,PDT,OR) |
| 6.9 | Pressure Gauge |
| 6.10 | Control Valves |
| 6.11 | Relief Valves |
| 6.12 | ESD Panel |
| 6.13 | Bulk Material (Cable Tray , Ladder , Earthing system) |
| 6.14 | Junction Box |
| **7** | **Construction Works** |
| 7.1 | Mechanical Works |
| 7.1.2 | Piping works |
| 7.1.3 | Piping Valves Instalation |
| 7.1.4 | Low Pressure Pump Installation |
| 7.2 | Electrical , instrumentation & control works |
| 7.2.1 | Power transformer Instalation |
| 7.2.2 | LV switchgears Instalation |
| 7.2.3 | Instumental Cables Instalation |
| 7.2.4 | Electrical Cables Instalation |
| 7.2.5 | Instrumentation Devies (PT,FT,PDT) Instalation |
| 7.2.6 | Pressure Gauge Instalation |
| 7.2.7 | Control Valve Instalation |
| 7.2.8 | Relief Valve Instalation |
| 7.2.9 | ESD Panel Instalation |
| 7.2.10 | General Works |
| 7.3 | Civil Works |
| 7.3.1 | Earthworks and foundation |
| 7.3.2 | Steel Structures and Shelters |
| 7.3.3 | General Works |
| 7.4 | Manpower and Equipment |
| 7.5 | General Works |
| 7.6 | Completion Works |
| 7.6.1 | Documention |

Figure 9- An example of a type of WBS for an EPC project
Source: Author's own



| Activity ID | Activity Name | Original Duration | Start | Finish |
|---|---|---|---|---|
| | | 1020 | 11-Dec-21 | 25-Sep-24 |
| **Key Milestone** | | 607 | 11-Dec-21 | 09-Aug-23 |
| KMWP1000 | Letter of award | 0 | 11-Dec-21 | |
| KMWP1010 | Commencement Date | 0 | 11-Dec-21 | |
| KMWP1020 | Effective Date | 0 | 11-Dec-21 | |
| KMWP1030 | Site Visit | 0 | 11-Dec-21 | |
| KMWP1040 | Approved MDR | 0 | 11-Dec-21 | |
| KMWP1050 | Finished PR I-III | 0 | | 05-Jun-22 |
| KMWP1060 | Finished PR. | 0 | | 11-Apr-22 |
| KMWP1070 | Finished SE I-III | 0 | | 19-Feb-23 |
| KMWP1080 | Finished SE. | 0 | | 02-Nov-22 |
| KMWP1090 | Finished PI I-III | 0 | | 24-Sep-22 |
| KMWP1100 | Finished PI | 0 | | 06-Jul-22 |
| KMWP1110 | Finished ME I-III | 0 | | 23-Mar-23 |
| KMWP1115 | Finished ME | 0 | | 07-Jul-22 |
| KMWP1120 | Finished HAVC I-III | 0 | | 25-Oct-22 |
| KMWP1125 | Finished HVAC | 0 | | 05-Apr-22 |
| KMWP1130 | Finished IN I-III | 0 | | 22-Nov-22 |
| KMWP1140 | Finished IN | 0 | | 17-Dec-22 |
| KMWP1150 | Finished EL I-III | 0 | | 19-Feb-23 |
| KMWP1160 | Finished EL | 0 | | 09-Nov-22 |
| KMWP1170 | Finished TE I-III | 0 | | 03-Jul-22 |
| KMWP1180 | Finished TE. | 0 | | 27-Apr-22 |
| KMWP1190 | Finished C/S/A I-III | 0 | | 11-Jun-23 |
| KMWP1200 | Finished C/S/A | 0 | | 09-Aug-23 |
| **Engineering Works** | | 618 | 11-Dec-21 | 20-Aug-23 |
| | | 618 | 11-Dec-21 | 20-Aug-23 |
| Project Management | | 5 | 11-Dec-21 | 15-Dec-21 |
| Procedure and report | | 5 | 11-Dec-21 | 15-Dec-21 |
| EWPPI | | 5 | 11-Dec-21 | 15-Dec-21 |
| EWPPI | Document Numbering Procedure | 5 | 11-Dec-21 | 15-Dec-21 |



Figure 10- An example for Type 1 of Time Schedule-Baseline
Source: Author's own

| Engineering S-Curve | 2021 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | | | | 12 | | | | 1 | | | | | 2 | | | | |
| | W1 | W2 | W3 | W4 | W1 | W2 | W3 | W4 | W1 | W2 | W3 | W4 | W5 | W1 | W2 | W3 | W4 | W1 |
| | 6-Nov | 13-Nov | 20-Nov | 27-Nov | 4-Dec | 11-Dec | 18-Dec | 25-Dec | 1-Jan | 8-Jan | 15-Jan | 22-Jan | 29-Jan | 5-Feb | 12-Feb | 19-Feb | 26-Feb | 5-Mar |
| Commulative Plan | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 2.39% | 13.20% | 14.27% | 15.78% | 18.17% | 18.86% | 20.14% | 23.67% | 26.21% | 27.54% | 30.41% |
| Periodic Plan | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 2.39% | 10.81% | 1.06% | 1.51% | 2.39% | 0.68% | 1.28% | 3.53% | 2.54% | 1.33% | 2.87% |
| Commulative Actual | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 11.19% | 11.71% | 16.12% | 17.72% | 17.72% | 18.69% | 19.10% | 21.75% | 23.76% | 25.14% |
| Periodic Actual | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 11.19% | 0.52% | 4.41% | 1.60% | 0.00% | 0.97% | 0.41% | 2.65% | 2.02% | 1.37% |

Figure 11- An example for Type 2 of Time Schedule
Source: Author's own

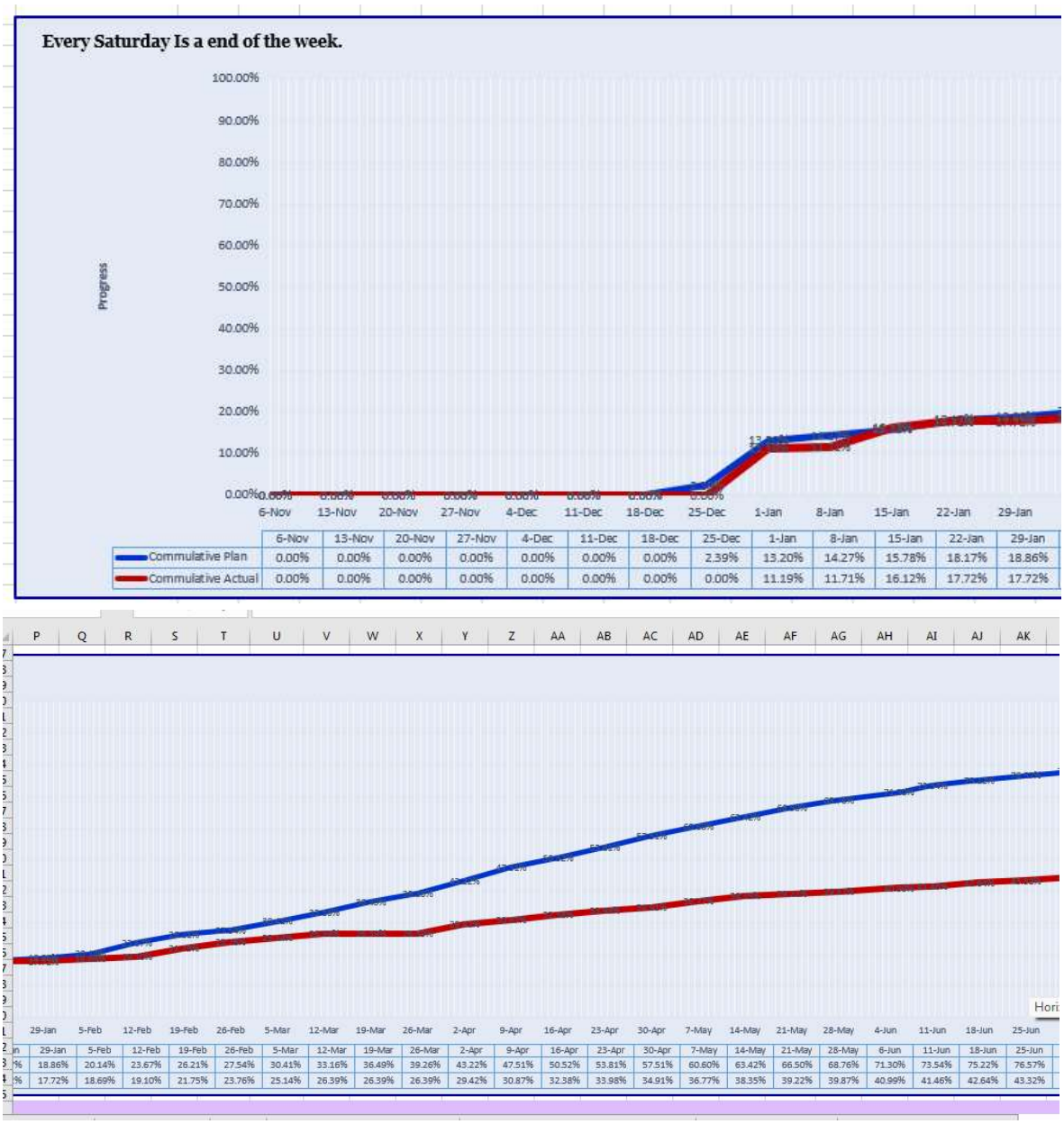



Figure 12- An example for Type 3 of Time Schedule
Source: Author's own

The amount of delay time causes a critical line and delay in the overall project time. Delays in each of the activities are generalized during the floating time of each activity and the whole project. Milestones at each time are determined when there is no dependence on other activities, so failure occurs at that time.

| | | | Date: | 2023-03-13 | |
|---|---|---|---|---|---|
| Document title | Class | Transmittal | Issued Date | Rev.No | P.O.I | Delay |
| MR For Firefighting Equipment | 2 | AWP-NRD-ZNV-T-22-1508 | 20-Nov-22 | D02 | IFA | -106 |
| MR For HVAC Exhaust Fans | 2 | AWP-NRD-ZNV-T-22-1530 | 23-Nov-22 | D02 | IFA | -103 |
| MTO For Pipeline | 3 | AWP-NRD-ZNV-T-22-1377 | 24-Oct-22 | D02 | IFI | -131 |
| MTO for piping for preparatory work | 3 | AWP-NRD-ZNV-T-22-0943 | 16-Jul-22 | D03 | IFI | -233 |
| MTO For Earthing & Lightning Protection | 3 | AWP-NRD-ZNV-T-22-1537 | 26-Nov-22 | D01 | IFI | -100 |
| Shutdown Philosophy | 3 | AWP-NRD-ZNV-T-22-1496 | 19-Nov-22 | D03 | IFI | -107 |
| Consequence Modeling Report | 2 | AWP-NRD-ZNV-T-22-1432 | 12-Nov-22 | D02 | IFA | -114 |
| Quantitative Risk Assessment (QRA) | 2 | AWP-NRD-ZNV-T-22-1536 | 26-Nov-22 | D02 | IFA | -100 |
| Environmental Job Specification | 3 | AWP-NRD-ZNV-T-22-1113 | 27-Aug-22 | D04 | IFI | -191 |
| Safety Sign And Evacuation Route Drawings for Process Area | 2 | AWP-NRD-ZNV-T-22-1183 | 12-Sep-22 | D02 | IFA | -175 |
| Firefighting And Safety Equipment Layout for Process Area | 2 | AWP-NRD-ZNV-T-22-1481 | 16-Nov-22 | D04 | AFC | -110 |
| H2S Area Classification Drawings | 2 | AWP-NRD-ZNV-T-22-1432 | 12-Nov-22 | D02 | IFR | -114 |
| Fire Fighting Water Network Distribution Layout | 2 | AWP-NRD-ZNV-T-22-1450 | 09-Nov-22 | D04 | AFC | -117 |
| Pipeline Data Sheets For Valves | 1 | AWP-NRD-ZNV-T-22-1528 | 23-Nov-22 | D02 | IFA | -101 |
| Data Sheet For Valves | 1 | AWP-NRD-ZNV-T-22-1333 | 10-Oct-22 | D02 | AFC | -145 |
| Plot Plan | 2 | AWP-NRD-ZNV-T-22-1533 | 23-Nov-22 | D04 | IFA | -103 |
| Piping Isometric Drawings for preparatory work | 2 | AWP-NRD-ZNV-T-22-1520 | 22-Nov-22 | D07 | AFC | -104 |
| Control Valve Calculation | 3 | AWP-NRD-ZNV-T-22-1521 | 23-Nov-22 | D02 | IFI | -103 |
| Data Sheet For On/Off Valves | 1 | AWP-NRD-ZNV-T-22-1519 | 22-Nov-22 | D03 | IFA | -102 |

Figure 13- An example for a type of WBS and Time Schedule with Delay Time
Source: Author's own

## 3.15. Budgeting and expenses

The costs that must be incurred to continue the process of doing the work, apart from the initial costs of the project, are called direct costs. Among the initial costs of the project are the cost of equipping the workshop, the charge of supplying and maintaining machinery, the fee of purchasing primary administrative supplies, the cost of providing equipment warehouse, and the initial housing costs of the workers to set up workshops and buildings.

Secondary costs and expenses resulting from the provision, maintenance, and implementation of projects to maintain an acceptable performance level of project equipment, additional salaries of specialists during implementation operations, and natural disasters, which are applied to the system, are considered indirect costs. Therefore, the Outlays in the process of carrying out projects are classified in such a way that the longer the project is delayed, the higher these costs will be.

Due to the delay in the project, the indirect costs applied to the project are as follows:

- At the time of participating in the tender, any type of mistake in calculating costs, production, machinery, etc., will increase the costs as the work progresses. For example, they calculate the type of expenditures, and by multiplying it, they increase the total cost exponentially.

- The initial budgeting of the project is estimated according to the basic design, preliminary drawings, and official documents taken from the employer during the bidding process. Failure to use the relevant specialists and experts while summarizing the budgets will increase the costs in the next stages and the continuation of the projects.
- The costs related to conducting relevant case tests and typical laboratory tests, not taking into account specific workshop specifications, team costs, and special cases related to HSE, can cause a lot of costs.
- In the tendering stage and collecting the initial documents to submit the initial proposal, the lack of expert staff and knowledge of the design details, especially the lack of access to specialist general contractors, can cause problems in the Detail Design and implementation stages that lead to an increase in costs.
- The lack of interface management and the lack of necessary coordination between departments can increase problems and costs. It is not only the initial designs that are important, but it is also important to pay attention to all the details until the testing, commissioning, and delivery.
- Outsourcing the work and estimating the overhead costs collectively, if implemented in the project, can impose a lot of additional costs on the project. One of the reasons for this is the lack of knowledge in that field, but the person or company that takes responsibility for this does accurate financial calculations, and huge costs are included in their contracts, which are imposed on the entire project.
- One of the important factors in this project is the transportation of equipment from abroad to the country. Because freight costs and insurance are constantly changing according to the general economy of the country, their unpredictability can cause a lot of costs.
- If, in the course of the project, there is a need to re-engineer, this can lead to re-production of the product, re-tests, re-installation, and re-starting, in addition to the cost of re-designing, which, in general, the total cost of all the steps will be recalculated. it is possible.
- The lack of coordination between technicians, experts, and financial accountants causes delays and additional costs.

It should be noted that some of the indirect costs may not have official documents, but should be known about these costs through interviews and inquiries. For example, the costs of forced one-time trips, the forced extension of trips and missions, the cost of expensive meetings with a large number of people, etc. Therefore, the detailed calculation of all the above costs can be effective, although they have a small effect on the total costs.

## 3.16. Interviews with subjects involved

As per section 3.8.2, following the initial series of interviews and surveys, subsequent interviews will integrate costs and schedules into the draft and qualitative questionnaires. These steps will be repeated to enhance the validity and accuracy of the work procedures. This time, materials were presented by the interviewees, which included the exact start date and time frame of a specific activity and the addition of a specific cost for a specific activity. These interviews are again conducted at different levels of technicians, experts, and management levels.

Considering that in industrial projects, all work and activities are directly or indirectly dependent on each other and the activities should be carried out in a chain, in qualitative analysis, the different levels mentioned above are required to Comment on each other's activities and methods. Because they don't know about the details of each other's activities, and the activities are dependent on each other, they can offer their opinions for the overall improvement of the activities; with this work, new perspectives are created in the project process, which can lead to improvement, accuracy, and increase the validity of the research.

## 3.17. Summary of Chapter

This section focuses on the various tools and techniques used to collect and analyze data and information for industrial projects, particularly Engineering, Procurement, and Construction (EPC) projects. Quantitative and qualitative methods are discussed to ensure a comprehensive understanding of the information-gathering process.

Quantitative methods involve collecting numerical data, which can be statistically analyzed to identify patterns, trends, and relationships between variables. These methods include surveys, questionnaires, and historical data analysis. The use of quantitative data helps in making objective decisions based on factual information. Qualitative methods, on the other hand, involve collecting non-numerical data such as observations, interviews, and case studies. These methods help understand certain phenomena' underlying reasons, opinions, and motivations. Using qualitative data helps make subjective decisions based on a deep understanding of the context.

The factors involved in collecting information include the purpose of the research, the nature of the data required, the availability of resources, and the time constraints. The methods and stages of information collection in industrial projects are also examined. These stages typically include planning, data collection, processing, analysis, and reporting. The validation of real information in the activities process is crucial to ensure the accuracy and reliability of the data. This involves cross-checking the data with various sources and verifying it with those directly involved in the projects.

Finally, ideas are provided to obtain the required information for EPC and industrial projects. These ideas are illustrated with examples from case studies in internal groupings of projects. This helps in understanding the practical application of the data collection and analysis methods in real-world scenarios.

In conclusion, this section provides a detailed overview of the data and information collection and analysis process in industrial projects, focusing on EPC projects. It emphasizes the importance of quantitative and qualitative methods and provides practical insights through case studies.

# Chapter 4
# Data Analysis

## 4.1. Introduction

In this chapter, the variance-based structural equation method (VB-SEM) is used to analyze the data and check the hypotheses of the model. Considering that the collected information is non-quantitative (qualitative), in the first step, this information should be converted into quantitative information, and in the next step, this information should be analyzed using statistical methods.

In this chapter, together with inferential statistics, descriptive statistics of the data obtained from the questionnaire will be presented, and then data analysis will be done based on inferential statistics and descriptive statistics with the help of appropriate statistical techniques in order to test the hypotheses. In this chapter, firstly, in the form of a demographic section, we will describe the respondents in terms of the research location, gender, and education level of the respondents, and finally, we will analyze the inferential data with SmartPLS 4.0.8.2 software.

## 4.2. Describing demographic characteristics

### 4.2.1. Description of community characteristics in terms of research location

In this part, the location of the research has been investigated, which is divided into two locations: the Project in the Oil industry and the Project in the Transport sector.

Table 12-Frequency distribution of respondents based on research location

| Location of researches | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|---|---|---|---|
| **Project A:** Project in the Oil industry | 187 | 48.6 | 187 | 48.6 |
| **Project B:** Project in the Transport sector | 198 | 51.4 | 385 | 100.0 |
| **Total** | 385 | 100.0 | | |

Cumulative Percentage=(Cumulative frequency/n) × 100
Source: Author's own

According to the findings of the table, among the 385 persons in the statistical sample, 187 persons, equivalent to 48.6%, were in the research site of the project in the oil industry (A), and 198 persons, equivalent to 51.4%, were carried out also in the research site of the project in the transport sector (B).

For a better understanding of the results of the above table, it is also reported in the form of a pie chart.

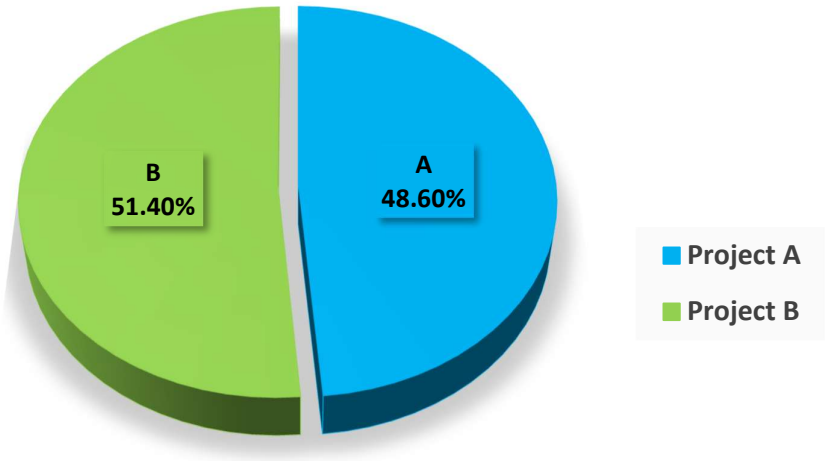



Figure 14 - Pie chart of frequency distribution of respondents based on research location
Source: Author's own

### 4.2.2. Describing the characteristics of community in terms of gender

One of the most important and basic questions related to respondents' demographics is their gender. The The table below shows the number of respondents, both male and female.

Table 13- Separation of respondents by gender

| Sex | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|---|---|---|---|
| Male | 284 | 73.8 | 284 | 73.8 |
| Female | 101 | 26.2 | 385 | 100.0 |
| **Total** | 385 | 100.0 | | |

Cumulative Percentage=(Cumulative frequency/n) × 100
Source: Author's own

As can be seen from the above table, the respondents are divided into two groups in terms of gender, men and women; among them, out of the total 385 statistical samples, 284 persons, equal to 73.8%, are men (C), and 101 persons are women (D), equal to 26.2%. It is obvious that the number of male respondents in this research is more than the number of women. Also, for a better understanding of the above numbers, the frequency distribution of the respondents is also displayed by gender through a pie chart.

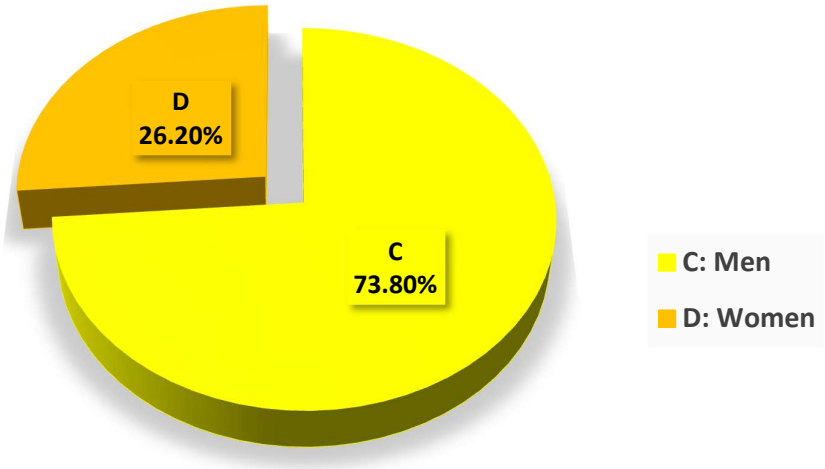



Figure 15-Frequency distribution of respondents in terms of gender
Source: Author's own

### 4.2.3. Describing the characteristics of community in terms of age variable

Knowing which age category of the respondents answered the questionnaire of the current research can provide useful information to the researchers. Therefore, as in previous researches, in this research, the respondents are separated from each other in terms of age. Among the 385 persons involved, 76 persons, equal to 19.7% are in the age group of 20-35 years (E), 133 persons are equal to 34.5% in the age group of 36-40 years (F), and 89 persons are equal to 23.1% in the age group of 41-45 years (G). 60 persons, equal to 15.6%, were in the age group of 46-50 years (H), and finally, 27 persons, equal to 7.0%, were in the age group of over 50 years (I).

According to the results, most respondents were in the age groups of 36-40 years (F), and the lowest observed age group is the age group of 50 years and above (I). Also, for a better understanding of the above results, this separation is displayed in the form of a pie chart.

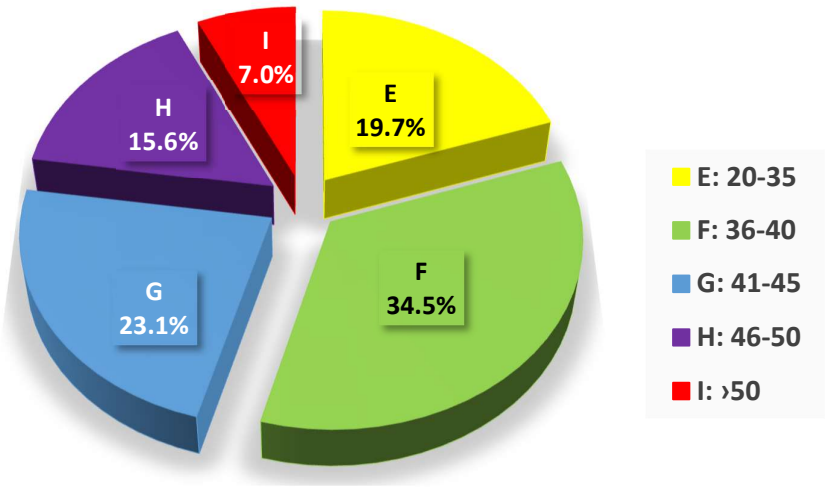



Figure 16-Frequency distribution of respondents according to age group
Source: Author's own

### 4.2.4. Describing the characteristics of community in terms of education

In the current study, our respondents are divided into three categories in terms of education level. Education as a demographic variable has been classified into three groups. Among the 385 statistical samples, 86 persons, equal to 22.3%, have a bachelor's education (J), 149 persons, equal to 38.7%, have a master's education (K), and 150 persons, equal to 39.0%, have a doctorate education (L).

The highest frequency was related to persons with a doctorate degree (L), and the lowest was related to persons with a bachelor's degree (J). Also, to better understand the difference between the respondents in terms of education, you can see more details in the pie chart below.

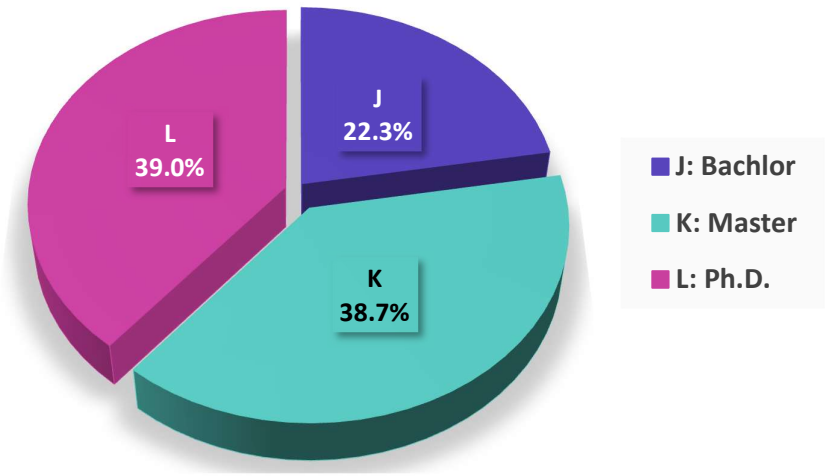



Figure 17-Pie chart of frequency of respondents according to education level
Source: Author's own

### 4.2.5. Describing the characteristics of community in terms of organizational levels

In the end, another demographic question in the current research is the organizational levels of the respondents. Among the 385 statistical samples, 89 participants, equal to 23.1%, are experts (M), 120 participants, equal to 31.2%, are in engineering organizational positions (N), 75 participants are equal to 19.5%, in the position of department manager (O), 32 participates are equal to 8.3% of engineer management (P); 33 participants, equivalent to 8.6%, were found in the position of project management (Q), and finally, 36 participants, equivalent to 9.4%, were found in the position of site/location management (R).

The results indicate that the highest frequency is related to the organizational position of engineering (N), and the lowest frequency is related to engineering management (P). Also, in the following, these results are presented in the form of a pie chart for better understanding.

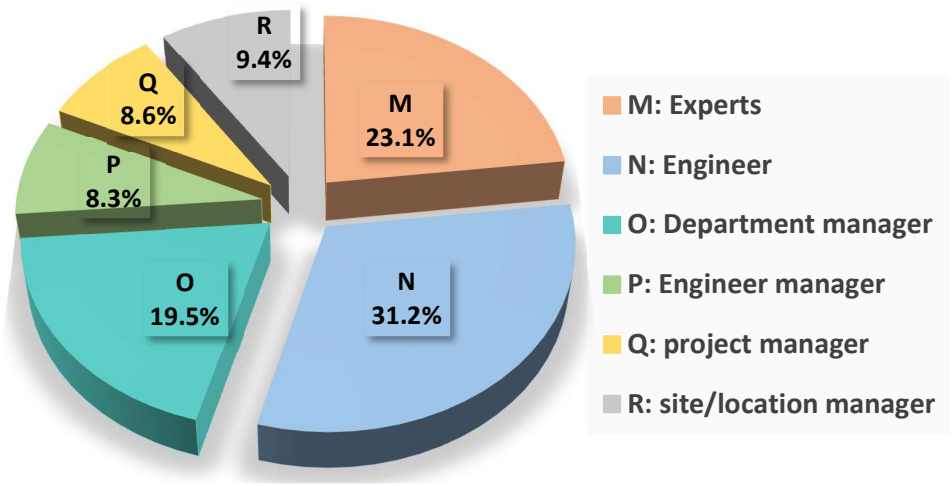



Figure 18-Pie chart of the breakdown of respondents in terms of years of service
Source: Author's own

## 4.3. Analysis of the research model

The analysis of models in the method of structural equations with the partial least squares (SE-PLS) approach consists of two main stages, including checking the model fit and then testing the research hypotheses. The model fitting stage includes three parts: measurement models, structural model fitting, and overall model fitting (Schuberth et al., 2023; Hair et al., 2012).

Convergent validity is investigated at both levels, the representative and the factor. At the representative level, the coefficients of factor loadings are taken into consideration, and the value of the criterion for the appropriateness of these coefficients is 0.4 (Hulland, 1999). By examining the research model in the mode of standard coefficients, it can be seen that all factor loadings are greater than 0.4, and thus, the convergent validity is confirmed at the representative level.

Table 14-External loads (outer components) of research structures

| Constructs | Type of constructs | Items | Coding | Outer loading |
|---|---|---|---|---|
| Technological Innovation | First Order Constructs | 9 | TI_01 | 0.822 |
| | | | TI_02 | 0.792 |
| | | | TI_03 | 0.799 |
| | | | TI_04 | 0.795 |
| | | | TI_05 | 0.796 |
| | | | TI_06 | 0.808 |
| | | | TI_07 | 0.817 |
| | | | TI_08 | 0.787 |
| | | | TI_09 | 0.820 |
| Production development | Low Order Construct | 10 | PD_01 | 0.783 |
| | | | PD_02 | 0.786 |
| | | | PD_03 | 0.786 |
| | | | PD_04 | 0.780 |
| | | | PD_05 | 0.796 |
| | | | PD_06 | 0.757 |
| | | | PD_07 | 0.762 |
| | | | PD_08 | 0.792 |
| | | | PD_09 | 0.789 |
| | | | PD_10 | 0.812 |
| ECRM | Low Order Construct | 7 | ECRM_01 | 0.796 |
| | | | ECRM_02 | 0.788 |
| | | | ECRM_03 | 0.797 |
| | | | ECRM_04 | 0.801 |
| | | | ECRM_05 | 0.805 |

| | | | | |
|---|---|---|---|---|
| | | | ECRM_06 | 0.786 |
| | | | ECRM_07 | 0.781 |
| Supply Chain Management | Low Order Construct | 6 | SCM_01 | 0.751 |
| | | | SCM_02 | 0.725 |
| | | | SCM_03 | 0.820 |
| | | | SCM_04 | 0.832 |
| | | | SCM_05 | 0.804 |
| | | | SCM_06 | 0.767 |
| Business Management | Low Order Construct | 9 | BM_01 | 0.802 |
| | | | BM_02 | 0.835 |
| | | | BM_03 | 0.795 |
| | | | BM_04 | 0.798 |
| | | | BM_05 | 0.819 |
| | | | BM_06 | 0.793 |
| | | | BM_07 | 0.814 |
| | | | BM_08 | 0.819 |
| | | | BM_09 | 0.803 |
| Strategic Management | High Order Constructs | 4 | Preferences in relationships | 0.810 |
| | | | Preferences in communication channels | 0.894 |
| | | | Priorities in customer service | 0.683 |
| | | | Preferences in goods and services | 0.876 |
| Preferences in relationships | Low Order Construct | 4 | PIR_01 | 0.868 |
| | | | PIR_02 | 0.860 |
| | | | PIR_03 | 0.865 |
| | | | PIR_04 | 0.871 |
| Preferences in communication channels | Low Order Construct | 3 | PICC_01 | 0.892 |
| | | | PICC_02 | 0.900 |
| | | | PICC_03 | 0.893 |
| Priorities in customer service | Low Order Construct | 3 | PICS_01 | 0.843 |
| | | | PICS_02 | 0.845 |
| | | | PICS_03 | 0.846 |
| Preferences in goods and services | Low Order Construct | 4 | PIGS_01 | 0.843 |
| | | | PIGS_02 | 0.855 |
| | | | PIGS_03 | 0.860 |
| | | | PIGS_04 | 0.869 |

Source: Author's own

Table 14 shows the external loadings (outer components) of the items corresponding to each structure. The criterion for accepting an item is external loadings above 0.4 and then checking the items that are between 0.4 and 0.7. Considering the above output, the external loads of

all items corresponding to each construct are above 0.7, and this indicates the excellent fit of the measurement models in terms of external loads.

The figure below presents measurement and structural models in the SmartPLS 4 software.

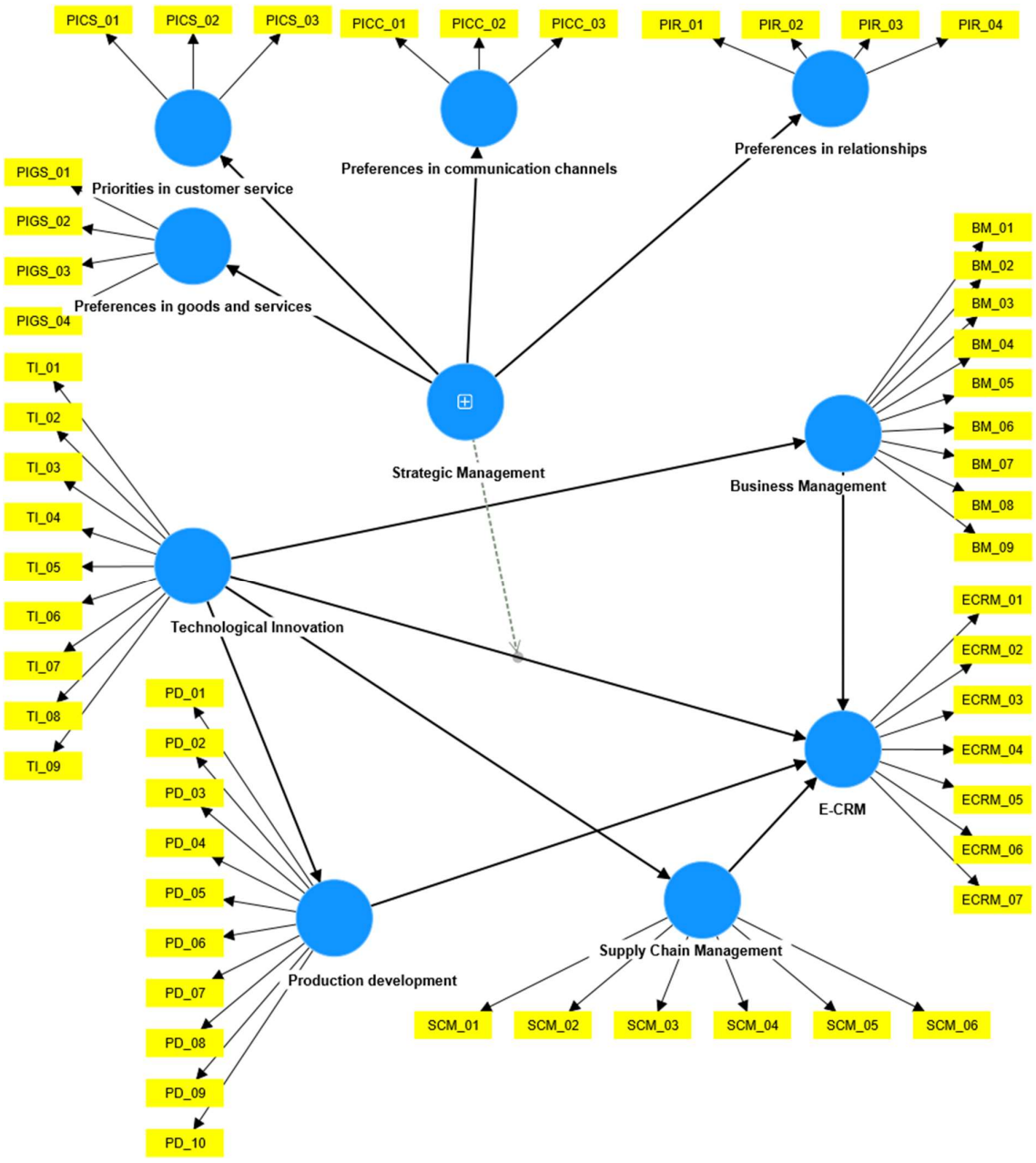



Figure 19-The measurement and structural model of the current research
Source: Author's own

### 4.3.1. The fit of the measurement model

In general, a measurement model is related to a part of the overall model that includes a variable along with questions related to it, and three criteria of convergent validity, divergent validity, and reliability are used to fit measurement models (Hair et al., 2017); (Ringle et al., 2023).

#### 4.3.1.1. Reliability

The criterion for evaluation is generally internal consistency reliability. A traditional measure of internal consistency is Cronbach's alpha, which provides an estimate of reliability based on the internal correlation of observed indicator variables. Cronbach's alpha assumes that all respondents are equally stable (all respondents have equal loadings on the construct). However, PLS-SEM prioritizes the reagents according to their individual reliability. In addition, Cronbach's alpha is sensitive to the number of items in each index and generally tends to underestimate internal consistency reliability. The value of this index should be above 0.7 (Hair et al.,2022; Hair et al., 2012).

Figure 15 shows the value of this index for research structures. Cronbach's alpha values are presented in the following table.

Table 15-Cronbach's alpha statistic values for research constructs

| Latent Variable | Cronbach's alpha |
|---|---|
| Business Management | 0.934 |
| ECRM | 0.902 |
| Preferences in communication channels | 0.876 |
| Preferences in goods and services | 0.879 |
| Preferences in relationships | 0.889 |
| Priorities in customer service | 0.800 |
| Production development | 0.929 |
| Supply Chain Management | 0.877 |
| Strategic Management | 0.924 |
| Technological Innovation | 0.932 |

Source: Author's own

Based on the findings of the above table, Cronbach's alpha coefficient for each variable is above 0.7, and the validity and reliability of the measurement tool are confirmed.

Due to the limitations of Cronbach's alpha in the community, it is permissible to use another measure of internal consistency reliability, which is called Composite Reliability (CR). This type

of reliability considers different external loads of representative variables. The appropriate value for this index is 0.7 (Hulland, 1999; Hair et al., 2020).

Table 16-Combined reliaility coefficient values for research constructs

| Latent Variable | Composite reliability (rho_a) |
|---|---|
| Business Management | 0.934 |
| ECRM | 0.902 |
| Preferences in communication channels | 0.876 |
| Preferences in goods and services | 0.880 |
| Preferences in relationships | 0.889 |
| Priorities in customer service | 0.800 |
| Production development | 0.930 |
| Supply Chain Management | 0.908 |
| Strategic Management | 0.927 |
| Technological Innovation | 0.932 |

Source: Author's own

Table 16 shows the amount of the combined reliability coefficient. The results indicate that the value of this statistic for all variables is above 0.7, and the fit of measurement models is also provided based on this criterion (Hair, Howard, & Nitzl, 2020; Ringle et al., 2023).

#### 4.3.1.2. Convergent validity

To check the convergent validity at the factor level, the Average Variance Extracted (AVE) Index is used, which, as mentioned in the third chapter, the minimum suitable value for this coefficient is 0.5 from the point of view of Fornell-Larker (1981) and from the point of view of Magner et al. (1996), the value is 0.4 (Hair et al., 2017).

Table 17-Average Variance Extracted (AVE) values of research variables

| Latent Variable | Average variance extracted (AVE) |
|---|---|
| Business Management | 0.654 |
| ECRM | 0.630 |
| Preferences in communication channels | 0.801 |
| Preferences in goods and services | 0.734 |
| Preferences in relationships | 0.750 |
| Priorities in customer service | 0.714 |
| Production development | 0.611 |
| Supply Chain Management | 0.615 |
| Strategic Management | 0.510 |
| Technological Innovation | 0.647 |

Source: Author's own

Table 17 shows the results of the average variance extracted (AVE) for research constructs. The criterion value for this index is to obtain a number above 0.5.

Based on the results of the above table, the value of the average variance extracted (AVE) is higher than the mentioned index, and the convergent validity of the structural model of the measurement models is confirmed.

According to the findings of the above figure and the tables related to the value of average variance extracted (AVE), the value of this index is higher than 0.5 for all latent variables. As a result, the convergent validity of the measurement models is confirmed.

According to Table 13, You can see the conceptual model of the current research, along with external loads and path coefficients, below:

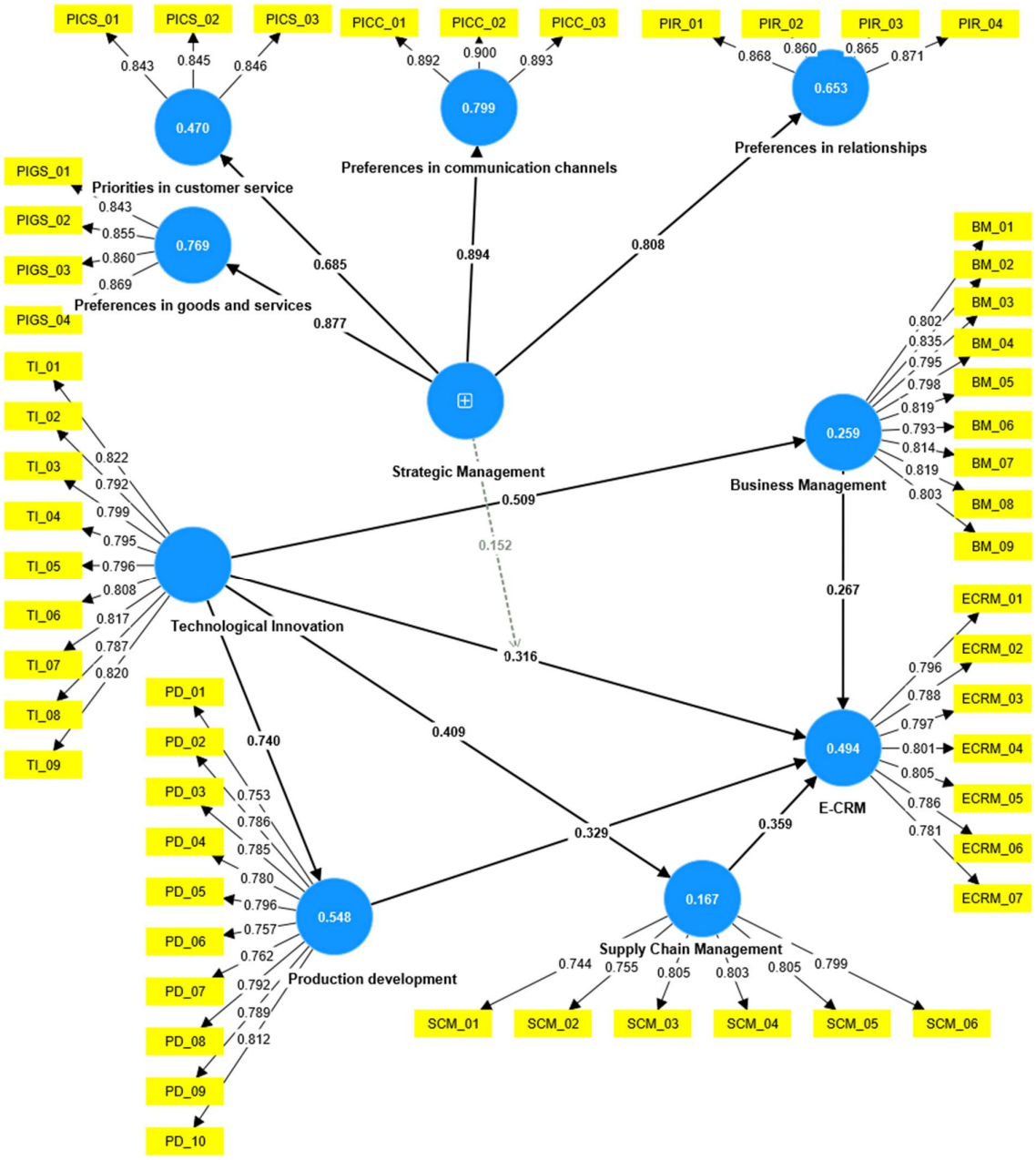



Figure 20-Conceptual research model with path coefficients and external loads
Source: Author's own

When certain constructs are removed, we observe fluctuations in the factor load of the associated items within the same construct. Consequently, the updated factor loads for all questions corresponding to each construct can be viewed in the aforementioned conceptual model. The subsequent table provides an overview of the reliability and validity metrics for the measurement models based on the constructs.

Table 17-An overview of the quality criteria of the model

| Latent Variable | ∂ | CR | AVE |
|---|---|---|---|
| Business Management | 0.934 | 0.934 | 0.654 |
| ECRM | 0.902 | 0.902 | 0.630 |
| Preferences in communication channels | 0.876 | 0.876 | 0.801 |
| Preferences in goods and services | 0.879 | 0.880 | 0.734 |
| Preferences in relationships | 0.889 | 0.889 | 0.750 |
| Priorities in customer service | 0.800 | 0.800 | 0.714 |
| Production development | 0.929 | 0.930 | 0.611 |
| Strategic Management | 0.877 | 0.908 | 0.615 |
| Supply Chain Management | 0.924 | 0.927 | 0.510 |
| Technological Innovation | 0.932 | 0.932 | 0.647 |
| AVE= Average variance extracted; CR= Composite reliability; ∂=Cronbach's alpha | | | |

Source: Author's own

Also, this statistic is presented as a histogram in the graph below.

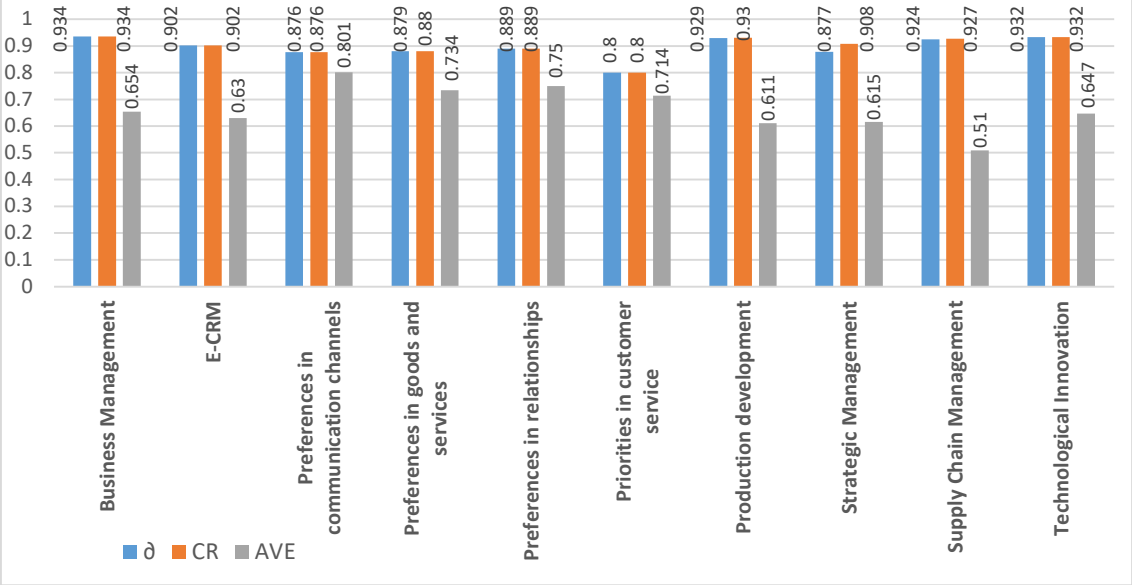



Figure 21-Histogram chart of CR coefficient, Cronbach's alpha coefficient, and AVE of research structures

Source: Author's own

### 4.3.2. Structural model fit

#### 4.3.2.1. Divergent validity

In this section, to measure the fit of measurement models, two methods of mutual factor loadings and the Fornell-Larcker method can be used. Divergent or discriminant validity is the extent to which a construct is correctly distinguished from other constructs by empirical criteria. Therefore, the realization of discriminant validity indicates that the construct is unique and the phenomenon encompassed is not represented by other constructs in the model.

Two criteria for discriminant validity have been proposed. A method to evaluate the discriminant validity is to examine the cross-sectional loadings of the factors. Specifically, the external load of a representative corresponding to the structure must be more than all the loads of that representative on other structures (transverse loads). The presence of transverse loads that exceed the external loads of the representative indicates the problem of differential validity. This measure of differential validity is a little weak (Hair et al., 2022).

#### 4.3.2.2. Fornell-Larker matrix

Fornell-Larker criterion is the second and more conservative approach to measure discriminant validity. This square root measure compares the value of the average variance extracted (AVE) with the correlation between the underlying variables. Specifically, the square root of each average variance extracted (AVE) of the construct must be greater than the highest correlation of that construct with other constructs in the model (this criterion can also be expressed as follows: the average variance extracted (AVE) must be greater than the square of the correlation of that construct with other model structures). The logic of this method is based on the assumption that a construct should share more variance with the corresponding variables than other constructs.

The following table shows the assessment of the Fornell-Larker criterion for the discriminant validity of the research model.

Table 18-Fornell-Larker criterion

| Raw | Latent Variable | Business Management | ECRM | Preferences in communication channels | Preferences in goods and services | Preferences in relationships | Priorities in customer service | Production development | Strategic management | Supply Chain Management | Technological Innovation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Business Management | 0.809 | | | | | | | | | |
| 2 | ECRM | 0.421 | 0.794 | | | | | | | | |
| 3 | Preferences in communication channels | 0.506 | 0.507 | 0.895 | | | | | | | |
| 4 | Preferences in goods and services | 0.333 | 0.519 | 0.743 | 0.857 | | | | | | |
| 5 | Preferences in relationships | 0.573 | 0.419 | 0.670 | 0.550 | 0.867 | | | | | |
| 6 | Priorities in customer service | 0.364 | 0.685 | 0.490 | 0.524 | 0.373 | 0.845 | | | | |
| 7 | Production development | 0.576 | 0.414 | 0.470 | 0.489 | 0.416 | 0.473 | 0.784 | | | |
| 8 | Strategic Management | 0.540 | 0.653 | 0.594 | 0.677 | 0.508 | 0.685 | 0.512 | 0.714 | | |
| 9 | Supply Chain Management | 0.568 | 0.320 | 0.353 | 0.432 | 0.481 | 0.593 | 0.611 | 0.418 | 0.786 | |
| 10 | Technological Innovation | 0.509 | 0.358 | 0.419 | 0.364 | 0.448 | 0.314 | 0.710 | 0.473 | 0.409 | 0.804 |

Source: Author's own

The average root of the extracted variance (AVE) on the diagonal elements and the correlation between the constructs are below them. For example, the reflective construct of Business Management has a value of 0.809 for its square root AVE, which should be compared with all correlation values in the Business Management column.

The results in Table 18 indicate that the square root of AVE for the reflective structures mentioned are all higher than the correlation of this structure with other latent variables in the path model. Therefore, the discriminant validity has been demonstrated. The problem that the Fornell-Larcker criterion aims to solve is establishing discriminant validity in research models by ensuring that each construct shares more variance with its corresponding variables than with other constructs, thereby confirming that the constructs are distinct and unrelated.

### 4.3.2.3. Heterotrait-Monotrait ratio of correlation (HTMT) matrix

In addition to convergent and construct validity, the current research has used the HTMT method to investigate the differential validity of measurement models. For differential validity analysis, questions of constructs should be larger compared to the factor loadings of other constructs (Henseler et al., 2015; Ringle et al., 2023; Hair et al., 2022).

The results of the analysis of the measurement model indicate that the HTMT index for the values of all structures is greater than the factor loads of other structures. This means that the HTMT value of each variable should be less than 0.85 or 0.90 (Henseler et al., 2015; Franke & Sarstedt, 2019; Hair et al., 2019). The output of the HTMT table is presented below.

Table 19-The results of the differential validity test of the HTMT index

| Raw | Latent variable | Business Management | ECRM | Preferences in communication channels | Preferences in goods and services | Preferences in relationships | Priorities in customer service | Production development | Strategic Management | Supply Chain Management | Technological Innovation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Business Management | | | | | | | | | | |
| 2 | ECRM | 0.457 | | | | | | | | | |
| 3 | Preferences in communication channels | 0.559 | 0.570 | | | | | | | | |
| 4 | Preferences in goods and services | 0.367 | 0.583 | 0.846 | | | | | | | |
| 5 | Preferences in relationships | 0.629 | 0.467 | 0.759 | 0.622 | | | | | | |
| 6 | Priorities in customer service | 0.421 | 0.638 | 0.586 | 0.625 | 0.443 | | | | | |
| 7 | Production development | 0.618 | 0.433 | 0.520 | 0.540 | 0.457 | 0.316 | | | | |
| 8 | Strategic Management | 0.585 | 0.724 | 0.769 | 0.641 | 0.798 | 0.812 | 0.549 | | | |
| 9 | Supply Chain Management | 0.625 | 0.356 | 0.401 | 0.486 | 0.316 | 0.344 | 0.673 | 0.458 | | |
| 10 | Technological Innovation | 0.545 | 0.323 | 0.464 | 0.402 | 0.493 | 0.363 | 0.795 | 0.511 | 0.442 | |

Source: Author's own

### 4.3.2.4. Meaning of external loads (outer components)

The next measure of the structural model fit check is the significant coefficient z, which can be obtained through the bootstrapping command, as shown in the figure below.

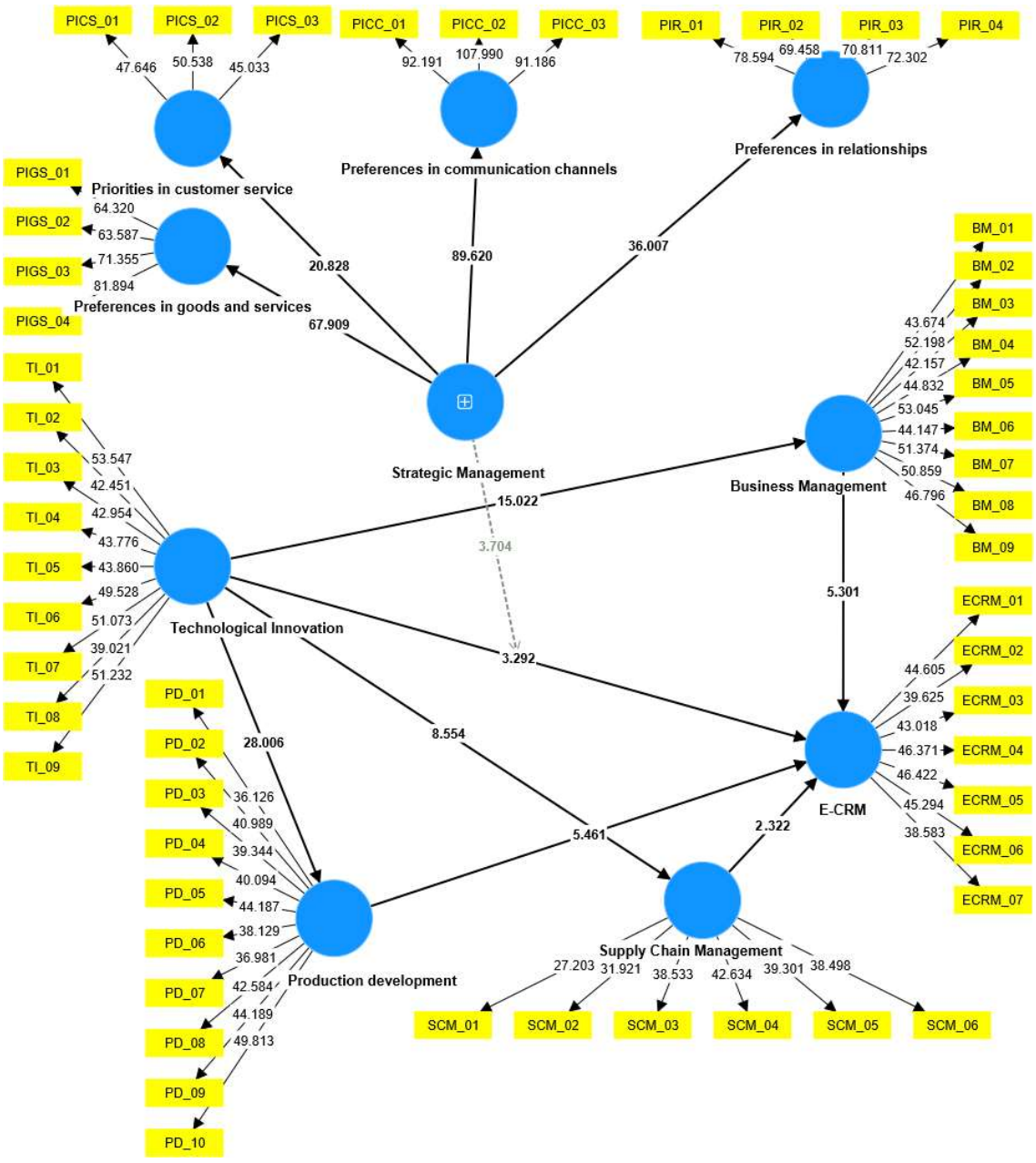



Figure 22-Conceptual research model with t-values
Source: Author's own

The conceptual research model in this study was analyzed using SmartPLS, a partial least squares structural equation modeling (PLS-SEM) tool. The significance of the relationships between the latent variables and their corresponding indicators was assessed using t-values. As depicted in the figure, all significant z-coefficients are greater than 1.96, indicating that the relationships between the variables and their respective items are statistically significant at the 95% confidence level. This implies that there is only a 5% probability that the observed relationships could have occurred by chance. Moreover, the t-values associated with the path coefficients between the latent variables were also evaluated to determine the significance of the proposed hypotheses.

The conceptual research model's analysis using SmartPLS provided robust statistical support for the relationships between the variables, their corresponding items, and the proposed hypotheses. The significant t-values demonstrate the reliability and validity of the research model, indicating that the findings are both statistically and practically significant.

Table 20-Significance table of external loads of research questions corresponding to each variable

| Constructs | Type of constructs | Items | Coding | t-value |
|---|---|---|---|---|
| Technological Innovation | First Order Constructs | 9 | TI_01 | 53.547 |
| | | | TI_02 | 42.451 |
| | | | TI_03 | 42.954 |
| | | | TI_04 | 43.776 |
| | | | TI_05 | 43.860 |
| | | | TI_06 | 49.528 |
| | | | TI_07 | 51.073 |
| | | | TI_08 | 39.021 |
| | | | TI_09 | 51.232 |
| Production development | Low Order Construct | 10 | PD_01 | 36.126 |
| | | | PD_02 | 40.989 |
| | | | PD_03 | 39.344 |
| | | | PD_04 | 40.094 |
| | | | PD_05 | 44.187 |
| | | | PD_06 | 38.129 |
| | | | PD_07 | 36.981 |
| | | | PD_08 | 42.584 |
| | | | PD_09 | 44.189 |
| | | | PD_10 | 49.813 |
| ECRM | Low Order Construct | 7 | ECRM_01 | 44.605 |
| | | | ECRM_02 | 39.625 |

| | | | | |
|---|---|---|---|---|
| | | | ECRM_03 | 43.018 |
| | | | ECRM_04 | 46.371 |
| | | | ECRM_05 | 46.422 |
| | | | ECRM_06 | 45.294 |
| | | | ECRM_07 | 38.583 |
| Supply Chain Management | Low Order Construct | 6 | SCM_01 | 27.203 |
| | | | SCM_02 | 31.921 |
| | | | SCM_03 | 38.533 |
| | | | SCM_04 | 42.634 |
| | | | SCM_05 | 39.301 |
| | | | SCM_06 | 38.498 |
| Business Management | Low Order Construct | 9 | BM_01 | 43.674 |
| | | | BM_02 | 52.198 |
| | | | BM_03 | 42.157 |
| | | | BM_04 | 44.832 |
| | | | BM_05 | 53.045 |
| | | | BM_06 | 44.147 |
| | | | BM_07 | 51.374 |
| | | | BM_08 | 50.859 |
| | | | BM_09 | 46.796 |
| Strategic Management | High Order Constructs | 4 | Preferences in relationships | 36.007 |
| | | | Preferences in communication channels | 89.620 |
| | | | Priorities in customer service | 20.828 |
| | | | Preferences in goods and services | 67.909 |
| Preferences in relationships | Low Order Construct | 4 | PIR_01 | 78.594 |
| | | | PIR_02 | 69.458 |
| | | | PIR_03 | 70.811 |
| | | | PIR_04 | 72.302 |
| Preferences in communication channels | Low Order Construct | 3 | PICC_01 | 92.191 |
| | | | PICC_02 | 107.990 |
| | | | PICC_03 | 91.186 |
| Priorities in customer service | Low Order Construct | 3 | PICS_01 | 47.646 |
| | | | PICS_02 | 50.538 |
| | | | PICS_03 | 45.033 |
| Preferences in goods and services | Low Order Construct | 4 | PIGS_01 | 64.320 |
| | | | PIGS_02 | 63.587 |
| | | | PIGS_03 | 71.355 |
| | | | PIGS_04 | 81.894 |

Source: Author's own

According to the above table, all significant z-coefficients are greater than 1.96, which shows the significance of all questions or items and relationships between variables at the 95% confidence level.

### 4.3.2.5. Coefficient of determination ($R^2$ value)

The most common measure used to evaluate the structural model is the coefficient of determination ($R^2$ value). An $R^2$ value of 0.75, 0.50, or 0.25 for endogenous variables, as a general rule, can be described as significant, moderate, and weak, respectively (Hair et al., 2022; Ringle et al., 2023; Hair et al., 2011; Henseler et al., 2009; Zhao & Li, 2022).

Table 21 shows the coefficient of determination for the endogenous structures of the research model.

Table 21-The coefficient of determination of the endogenous structure of the research model

| Latent variable | R-square | R-square adjusted |
|---|---|---|
| Business Management | 0.259 | 0.257 |
| ECRM | 0.494 | 0.486 |
| Preferences in communication channels | 0.799 | 0.798 |
| Preferences in goods and services | 0.769 | 0.769 |
| Preferences in relationships | 0.653 | 0.652 |
| Priorities in customer service | 0.470 | 0.468 |
| Production development | 0.548 | 0.546 |
| Strategic Management | 0.225 | 0.223 |

Source: Author's own

According to the findings of the above table, the coefficient of determination for the variables of "Business Management", "Priorities in customer service", and "Strategic Management" is equal to 0.259, 0.470, and 0.225, respectively. This is while for the rest of the related endogenous structures, the coefficient of determination has been calculated as high as 0.50 and 0.75, which indicates the optimal fit of the structural model in terms of the predictive power of the endogenous variables.

The coefficient of determination (R-square) is a statistical measure that indicates the proportion of the variance in the dependent variable that is predictable from the independent variables. In this case, the R-square values indicate the proportion of variance in each latent variable that the exogenous variables in the research model can explain. The R-square values for "Business Management", "Priorities in customer service", and "Strategic Management" are relatively low, indicating that these exogenous variables in the model have limited

predictive power for these latent variables. In contrast, the R-square values for the other latent variables are higher, indicating that the exogenous variables have stronger predictive power for these variables. The R-square adjusted values consider the number of independent variables in the model and provide a more conservative estimate of the model's predictive power.

#### 4.3.2.6. $Q^2$ forecasting criterion and predictor fit

In addition to evaluating the magnitude of the $R^2$ value as a measure of predictive accuracy, researchers should examine the Stone-Geisser $Q^2$ value (Stone, 1974; Chin et al., 2020). This measure is an indicator of model predictor fit. If the value of $Q^2$ in the case of an endogenous construct is 0.02, 0.15, and 0.35, it indicates the weak, medium, and strong predictive power of the construct with related exogenous constructs, respectively.

The results of the following table show the appropriate predictive power of the model regarding the endogenous structures of the research and confirm the fit of the structural model.

Table 22-$Q^2$ criterion results for endogenous constructs

| | SSO | SSE | $Q^2$ (=1-SSE/SSO) |
|---|---|---|---|
| Business Management | 3465 | 2887.009 | 0.167 |
| ECRM | 2695 | 1834.706 | 0.319 |
| Preferences in communication channels | 1155 | 422.069 | 0.635 |
| Preferences in goods and services | 1540 | 683.052 | 0.556 |
| Preferences in relationships | 1540 | 786.683 | 0.489 |
| Priorities in customer service | 1155 | 773.709 | 0.330 |
| Production development | 3850 | 2608.499 | 0.322 |
| Strategic Management | 5390 | 4797.87 | 0.110 |

(SSE: Sum of the Squared prediction Errors, SSO: Sum of the Squared Observations)
Source: Author's own

A $Q^2$ value greater than zero indicates that the model has a significant predictive fit for an endogenous construct. On the other hand, lower values show the lack of fit of the predictor. The $Q^2$ value related to the research constructs is in the acceptable range between 0.15 and 0.35, which indicates a very favorable fit of the structural model in terms of the $Q^2$ value.

### 4.3.3. Overall model fit

After examining the fit of measurement and structural models, the fit of the overall research model will now be examined. Henseler and Sarstedt (2013) have recently challenged the

usefulness of this index conceptually and empirically. Their study shows that GoF does not provide a good goodness-of-fit measure for PLS-SEM. Especially, unlike the CB-SEM fit measure, GoF does not have the ability to separate valid models from invalid models. Since GoF cannot be used for formative measurement models and does not warn attempts to overestimate parameters, and does not impose a penalty for them, researchers do not suggest using this measure (Zhao & Li, 2022).

In general, when we use the fourth version of SmartPLS (SmartPLS V.4), we have two model fit indices, one of which is Standardized Root Mean square Residual (SRMR), whose value should be less than 0.08 (Schuberth et al., 2023; Cho et al., 2020; Hu & Bentler, 1999). If the value of this index is less than 0.08, an acceptable fit is concluded. In the present study, this value is equal to 0.0796.

Table 23-Model fit values

| Model of Fit | Criteria | Value | Conclusion |
|---|---|---|---|
| SRMR | < 0.08 | 0.0796 | Indicating acceptable model fit |
| NFI | > 0.9 | 0.898 | Indicating acceptable model fit |
| RMS Theta | < 0.12 | 0.061 | Indicating acceptable model fit |

Source: Author's own

Based on the above tables, this index is also at its acceptable threshold, so it can be claimed that the current research model has a very good fit (Bentler & Bonett, 1980; Lohmoller, 1989; Henseler et al., 2014). Now, after analyzing the fit of measurement and structural models and finally fitting the general model, we are allowed to prove and reject the research hypotheses.

## 4.4. Examining research hypotheses

In this section, research hypotheses are examined. In the current research, nine (9) hypotheses were proposed, which are as follows:

H1. Technological Innovation has a strong effect on ECRM.

H2. Technological Innovation has a strong effect on Supply Chain Management.

H3. Supply Chain Management has a strong effect on ECRM.

H4. Technological Innovation has a strong effect on Business Management.

H5. Business Management has a strong effect on ECRM.

H6. Supply Chain Management mediates the effect of Technological Innovation on ECRM.

H7. Business Management mediates the effect of Technological Innovation on ECRM.

H8. Production development mediates the effect of Technological Innovation on ECRM.

H9. Strategic management moderates the effect of Technological Innovation on ECRM.

The table below reports the significance of the relationships between the variables mentioned in the above hypotheses.

Table 24-PLS standardized path coefficients

| Hypotheses | Path coefficient (β) | STDEV | T-statistics | p-Values | Support |
|---|---|---|---|---|---|
| H1: Technological Innovation -> ECRM | 0.316 | 0.054 | 3.292 | 0.049 | YES |
| H2: Technological Innovation -> Supply Chain Management | 0.409 | 0.048 | 8.554 | 0.000 | YES |
| H3: Supply Chain Management -> ECRM | 0.359 | 0.044 | 2.322 | 0.046 | YES |
| H4: Technological Innovation -> Business Management | 0.509 | 0.034 | 15.022 | 0.000 | YES |
| H5: Business Management -> ECRM | 0.267 | 0.05 | 5.301 | 0.000 | YES |
| H6: Technological Innovation -> Supply Chain Management -> ECRM | 0.224 | 0.018 | 2.309 | 0.001 | YES |
| H7: Technological Innovation -> Business Management -> ECRM | 0.136 | 0.027 | 4.967 | 0.000 | YES |
| H8: Technological Innovation -> Production development -> ECRM | 0.244 | 0.045 | 5.393 | 0.000 | YES |
| H9: Strategic Management x Technological Innovation -> ECRM | 0.152 | 0.041 | 3.704 | 0.000 | YES |
| *p<0.10(90%), **p<0.05(95%), ***p<0.001(99%) | | | | | |

Source: Hair Jr. et al. (2021)

The table above presents the outcomes of testing and rejecting research hypotheses. It is important to note that a hypothesis can be considered proven if the t-value or t-statistic exceeds 1.96. Consequently, at a 95% confidence level, it can be asserted that the hypothesis is valid. Alternatively, a hypothesis can be confirmed through the p-value statistic. If this value is less than 0.05, the hypothesis is accepted as accurate, whereas if it exceeds 0.05, it is rejected. Based on the findings presented in the table, the first hypothesis has been confirmed at a 95% confidence level. What is more, the remaining, from 2 to 9, were also confirmed with a 99% confidence level.

## 4.5. Checking the type of mediation

In the current research, hypotheses 6 to 8 are the indirect effects of Technological Innovation on ECRM in the presence of three mediations: Supply Chain Management, Business Management, and Production Development.

All three hypotheses were confirmed at the 95% confidence level (also, at 99% because of p-values of 0.000). Now, with the aim to specify the type of mediation in this section, the Variance Accounted For (VAF) index was used. The decision regarding the VAF index is made based on the following figure (Zhao et al., 2010; Nitzl et al., 2016; Nitzl et al., 2017; Hair et al., 2022):

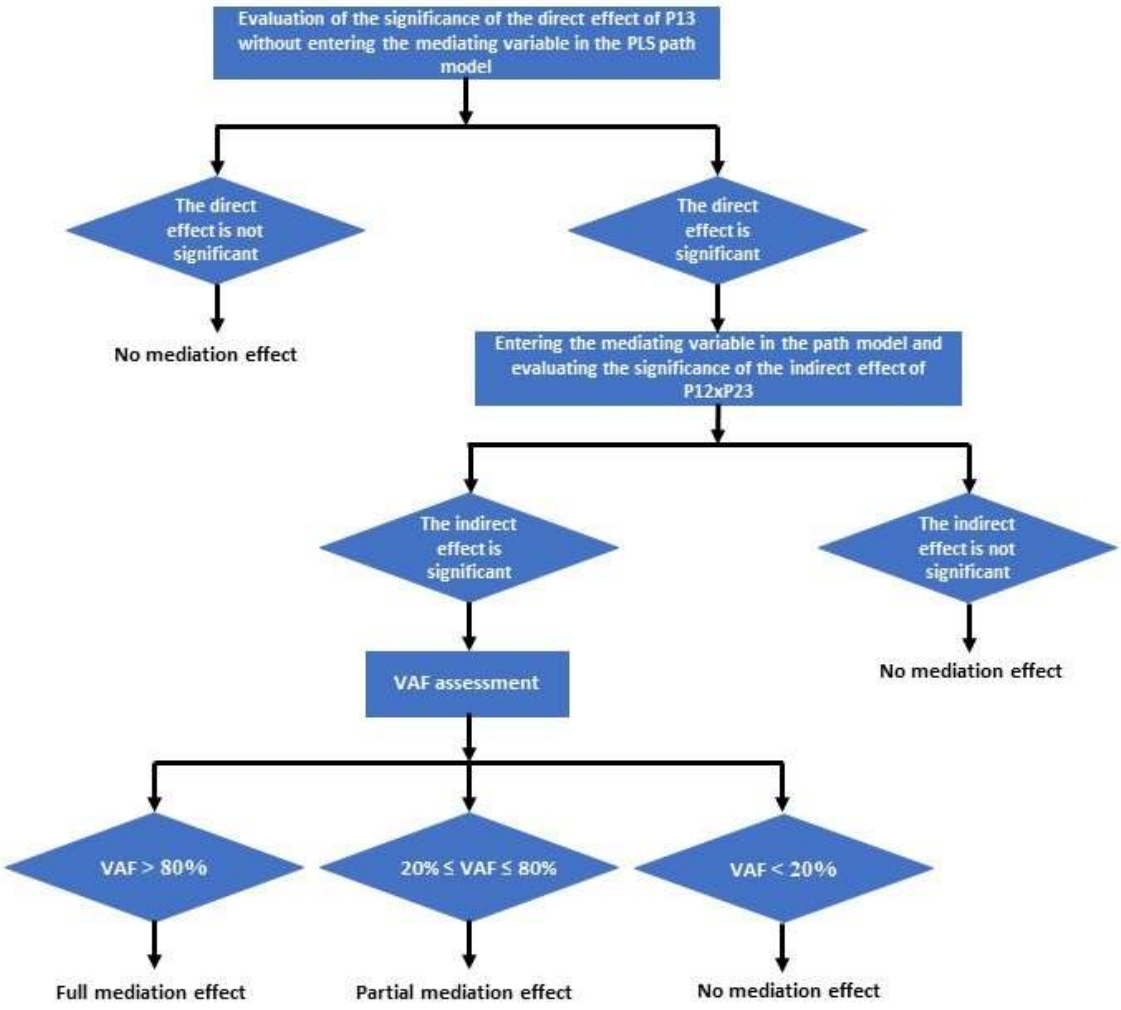



Figure 23-Mediator variable analysis procedure in PLS-SEM
Source: Zhao et al. (2010); Nitzl et al. (2016); Hair et al., 2017; Hair Jr. et al. (2021)

Variance Accounted For (VAF) is used to determine the absorption of the effect by the mediating variable (Figure 24). VAF determines the size of the indirect effect relative to the total effect (indirect effect + direct effect) (Cohen, 1988; Hair et al., 2017):

$$VAF = \frac{P_{12} \times P_{23}}{(P_{12} \times P_{23}) + P_{13}}$$

$P_{12} \times P_{23}$: Significant indirect effect (13)

$P_{13}$: Insignificant direct effect

Yn: Hypothesis

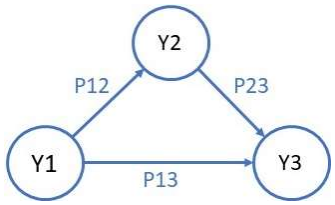



Figure 24-Variance Accounted For
Source: Zhao et al. (2010); Hair Jr. et al. (2021)

As a result, it is possible to determine how much the variance of the dependent variable is explained directly by the independent variable and how much the variance of the target construct is explained by indirect relationships through the mediating variable.

If the indirect effect is significant but does not convey the impact of the exogenous dependent variable on the endogenous variable, the Variance Accounted For (VAF) tends to be low. This occurs when the direct effect is substantial, and upon incorporating a mediating variable with a significant indirect effect, it experiences a minor decrease. Consequently, the VAF value will be less than 20%, suggesting that mediation has not occurred. On the other hand, if the VAF value is considerably large and exceeds 80%, it indicates complete mediation. In cases where the VAF value falls between 20% and 80%, the mediation is considered partial.

Table 25-Examining the state of the mediation hypotheses

| Hypothesis | VAF | Type of mediation |
|---|---|---|
| H6: Technological Innovation -> Supply Chain Management -> ECRM | 0.317 | Partial Mediation |
| H7: Technological Innovation -> Business Management -> ECRM | 0.301 | Partial Mediation |
| H8: Technological Innovation -> Production development -> ECRM | 0.435 | Partial Mediation |

Source: Author's own

Based on the above table, for all three paths of hypotheses 6 to 8, the value of the VAF index was calculated as 0.317, 0.301, and 0.435, respectively, and because this value is higher than 20% and lower than 80%, therefore, the status of all mediations was identified as partial mediation.

## 4.6. Examining the role of moderation

In the current research, the effect of the independent variable of Technological Innovation on ECRM was moderated by Strategic Management, which was discussed in hypothesis H9. The hypothesis in question was supported, and in this section, the aim is to illustrate the interaction diagram of the moderator variable in the context of two independent and dependent variables. To draw the diagram of the interaction, the macro of Professor James Gasiken has been used, the output of which is reported in Figure 25 (Dawson, 2014; Gaskin & Liam, 2016):

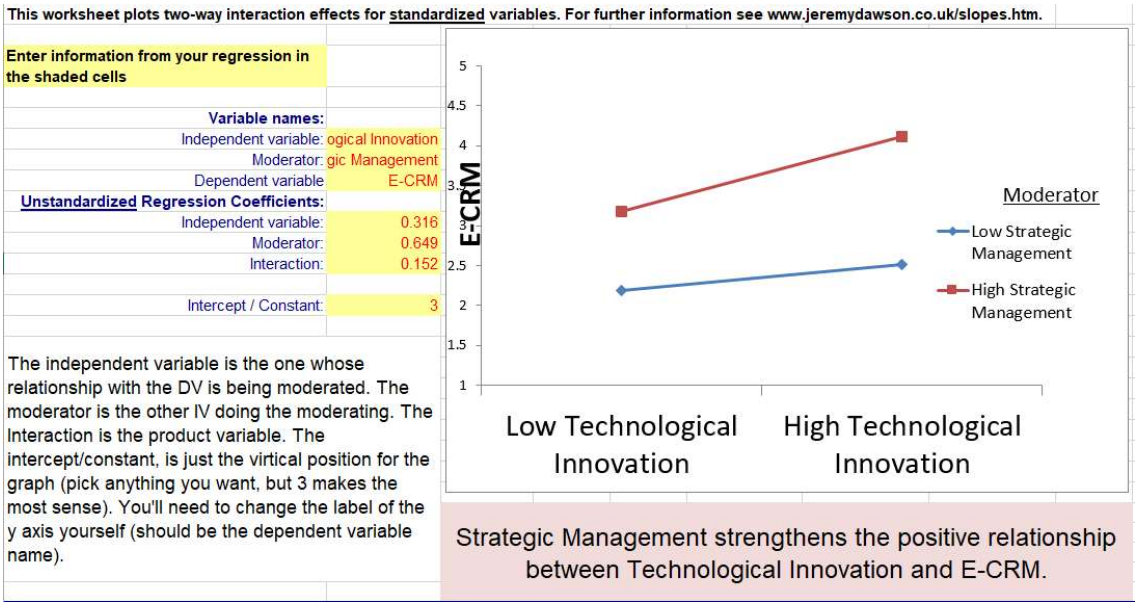



Figure 25-Professor James Gaskin's interaction diagram

The above image shows the interaction effect of the moderator variable of Strategic Management. Based on the above figure, the slope of the blue line when there is a low level of Strategic Management has a relatively high slope, which has a lower slope than the upper red line in the presence of a high level of Strategic Management. In other words, when there is a high level of Strategic Management in the model, then the effect of Technological Innovation on ECRM is adjusted positively.

Therefore, the interaction diagram provides a visual representation of the results of hypothesis H9, which tested the moderating effect of Strategic Management on the relationship between Technological Innovation and ECRM. The diagram supports the

hypothesis that Strategic Management moderates the relationship between Technological Innovation and ECRM.

## 4.7. Summary of the chapter

In this chapter, the data obtained from the questionnaires were analyzed. For this purpose, by using the structural equation method and SmartPLS 4 software, the relationship between the types of research and demographic variables in the conceptual model was determined. In this research, nine (9) main hypotheses were examined.

The significance of all hypotheses is confirmed at a 95% confidence level. Hypotheses number sixth (6) to eighth (8) are related to the investigation of the mediation of the three variables Supply Chain Management, Business Management, and Production Development, and their VAF index value was calculated as 0.317, 0.301 and 0.435 for the sixth (6) to eighth (8) hypotheses, respectively, which is greater than 20% and smaller than 80%, and this mediation is a type of partial mediation.

In this regard, the results of the study provide valuable insights in several ways:

Evidence-Based Decision Making: Confirming all nine hypotheses at a 95% confidence level provides robust evidence that can be used to inform decision-making in research types and demographic variables.

Understanding the Role of Mediating Variables: The study's findings on the partial mediation of Supply Chain Management, Business Management, and Production Development (hypotheses six to eight) are particularly significant. Decision-makers can leverage this understanding to optimize these areas, which can indirectly influence the outcomes of interest.

Prioritization of Resources: The VAF index values for the sixth to eighth hypotheses (0.317, 0.301, and 0.435, respectively) can help decision-makers prioritize resources. For instance, the higher VAF value for Production Development (0.435) suggests that investments in this area may have a larger impact.

Informing Future Research: The findings of this study can be used to identify areas where further research is needed. For instance, future studies could aim to replicate these findings in different contexts or explore other potential mediating variables.

Policy Development and Implementation: The findings can be used to develop and implement policies to improve outcomes in research types and demographic variables. For instance, policies could be developed to promote adopting best practices in Supply Chain Management, Business Management, and Production Development.

# Chapter 5
# Results and Conclusion

## 5.1. Introduction

The purpose of conducting any research is to provide answers to the research questions and draw conclusions about the stablished hypotheses so that one can finally draw conclusions about the research topic and the research problem. The current chapter reviews the research and its findings in the form of a summary, discusses, and draws conclusions. At the end, suggestions are made based on the results and proposed for future research.

## 5.2. Summary of the research

This research proposes “A Model for Estimating the Success of Electronic Customer Relationship Management (ECRM) Systems in Industry Management” in the form of two projects, in the Oil industry and the Transport sector, the study has taken a statistical sample among 385 persons, men, and women, 20 years old to over 50 years old, with bachelor, master and doctorate education.

The first chapter of the thesis is dedicated to the generalities of the research, including the statement of the problem, the necessity of the survey, and its importance. In the second chapter, the review was conducted on both the research literature and previous research. The third chapter of the thesis is devoted to the description of research methodology and the knowledge of various methods, and the fourth chapter is also dedicated to data analysis.

The statistical population of this research were experts, engineers, department managers, engineer managers, project managers, and site managers who were currently working on the mentioned projects. The sampling method is stratified random.

The data needed for the research were collected through standard questionnaires, and the questionnaires were provided to the relevant personnel and people. Cronbach's alpha of the questionnaire for the research variables was higher than 0.7 on average, which indicates the adequate reliability of the questionnaire. Descriptive and inferential statistics were used to analyze the research data, which was done by SmartPLS 4 software.

## 5.3. Research findings

### 5.3.1. Inferential findings (hypotheses test results)

In the research, after examining the fit of measurement models, the structural model and general model were based on a data analysis algorithm in SmartPLS 4 software.

The inferential findings related to rejecting or proving research hypotheses can now be examined and discussed. Subsequently, the status of rejection or acceptance will be reported for all nine hypotheses.

H1. Technological Innovation has a strong effect on ECRM.

In the first hypothesis of the current research, the amount and significance of the impact of the Technological Innovation variable on ECRM was measured. The path coefficient of this relationship is equal to 0.316, which has a significant t-value equal to 3.292, and the significance of the p-value is less than 0.071. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the first hypothesis regarding the impact of Technological Innovation on ECRM with a 90% confidence level. The type of relationship between two variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the independent variable of Technological Innovation, the value of ECRM will increase by 31.6%.

H2. Technological Innovation has a strong effect on Supply Chain Management.

In the second hypothesis of the current research, the extent and significance of the impact of the Technological Innovation variable on Supply Chain Management was measured. The path coefficient of this relationship is equal to 0.409, which has a significant t-value equal to 8.554, and the significance of the p-value is less than 0.000. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the second hypothesis based on the impact of Technological Innovation on Supply Chain Management with an error level of a confidence level of 95%. The type of relationship between two variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the independent variable of Technological Innovation, the value of Supply Chain Management will increase by 40.9%.

H3. Supply Chain Management has a strong effect on ECRM.

In the third hypothesis of the current research, the amount and significance of the variable Supply Chain Management on ECRM was measured. The path coefficient of this relationship is equal to 0.359, which has a significant t-value equal to 2.322, and the significance of the p-value is less than 0.046. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the first hypothesis regarding the effect of Supply Chain Management on ECRM with an error level of a confidence level of 95%. The type of relationship between two variables is a positive relationship, the

reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the independent variable of Supply Chain Management, the value of ECRM will increase by 35.9%.

H4. Technological Innovation has a strong effect on Business Management.

In the fourth hypothesis of the current research, the extent and significance of the impact of the Technological Innovation variable on Business Management was measured. The path coefficient of this relationship is equal to 0.509, which has a significant t-value equal to 15.022, and the significance of the p-value is less than 0.000. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the fourth hypothesis based on the impact of Technological Innovation on Business Management with an error level of a confidence level of 95%. The type of relationship between two variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if a unit is added to the independent variable of Technological Innovation, the amount of Business Management will increase by 50.9%.

H5. Business Management has a strong effect on ECRM.

In the fifth hypothesis of the current research, the extent and significance of the effect of the Business Management variable on ECRM was measured. The path coefficient of this relationship is equal to 0.267, which has a significant t-value equal to 5.301, and the significance of the p-value is less than 0.000. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the fifth hypothesis based on the effect of Business Management on ECRM with an error level of a confidence level of 95%. The type of relationship between two variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if a unit is added to the independent variable of Business Management, the value of ECRM will increase by 26.7%.

H6. Supply Chain Management mediates the effect of Technological Innovation on ECRM.

In the sixth hypothesis of the current research, the extent and significance of the impact of the Technological Innovation variable on ECRM was measured with the presence of the

mediation role of the Supply Chain Management variable. The indirect path coefficient of this relationship is equal to 0.224, which has a significant t-value equal to 2.309, and a p-value significance of less than 0.001. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the sixth hypothesis based on the impact of Technological Innovation on ECRM with the mediation role of Supply Chain Management at the 95% confidence level. The type of relationship between the three variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the intermediary variable of Supply Chain Management, the impact of Technological Innovation on ECRM will increase by 22.4%.

H7. Business Management mediates the effect of Technological Innovation on ECRM.

In the seventh hypothesis of the current research, the extent and significance of the impact of the Technological Innovation variable on ECRM was measured with the presence of the mediating role of the Business Management variable. The indirect path coefficient of this relationship is equal to 0.136, which has a significant t-value equal to 4.967, and a p-value significance of less than 0.000. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the seventh hypothesis regarding the impact of Technological Innovation on ECRM with the mediating role of Business Management at the 95% confidence level. The type of relationship between the three variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the intermediary variable of Business Management, the impact of Technological Innovation on ECRM will increase by 13.6%.

H8. Production development mediates the effect of Technological Innovation on ECRM.

In the eighth hypothesis of the current research, the amount and significance of the effect of the Technological Innovation variable on ECRM was measured with the presence of the mediating role of the Production development variable. The coefficient of the indirect path of this relationship is equal to 0.244, which has a significant t-value equal to 5.393, and the significance of the p-value is less than 0.000. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the

eighth hypothesis based on the impact of Technological Innovation on ECRM with the mediating role of Production development at the 95% confidence level. The type of relationship between the three variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the intermediate variable of Production development, the effect of Technological Innovation on ECRM will increase by 24.4%.

H9. Strategic management moderates the effect of Technological Innovation on ECRM.
In the ninth hypothesis of the current research, the extent and significance of the impact of the Technological Innovation variable on ECRM was measured with the presence of the moderator role of the Strategic Management variable. The coefficient of the direct path of this relationship is equal to 0.152, which has a significant t-value equal to 3.704, and the significance of the p-value is less than 0.000. The mentioned statistics are 1.96 more and 0.05 less than the two indicators, respectively. Therefore, we can confirm the significance of the ninth hypothesis based on the impact of Technological Innovation on ECRM with the moderating role of the Strategic Management variable at the 95% confidence level. The type of relationship between the three variables is a positive relationship, the reason for which is the positive sign of the path coefficient. According to the findings, if one unit is added to the Strategic Management modulating variable, the impact of Technological Innovation on ECRM will increase by 15.2%. In other words, the Strategic Management modulating variable positively and significantly increases and strengthens the relationship between the two variables of Technological Innovation and ECRM.

In this section, following the validation of the research hypotheses, a brief overview of the study's background, which was conducted in the theoretical foundations and literature of the research, was presented in the second chapter. This aims to validate our results and achievements by presenting relevant research related to the hypotheses.
According to the above results, Table 6, presented in Chapter 2, provides an overview of the studies conducted by various authors on the relationship between Technological Innovation, ECRM, SCM, Business Management, and Production Development. The main ideas, results, and alignment with the hypotheses proposed in this study are discussed for each reference.

Several studies support the alignment with the hypotheses proposed in this research. For instance, Almajali et al. (2022) and Damabi et al. (2018) highlight the significance of Technological Innovation in ECRM, which aligns with H1. Baha (2023) emphasize the importance of Technological Innovation in SCM, supporting H2. Lasyoud and Alsharari (2017) and Gencer (2020) demonstrate the positive impact of SCM on ECRM, aligning with H3. Abdi et al. (2020) and Chatterjee et al. (2021) show the relationship between Technological Innovation and Business Management, which is in line with H4. Libai et al. (2020) and Kamboj et al. (2018) focus on the connection between Business Management and ECRM, supporting H5.

Additionally, some studies explore the combined effects of these variables. Alshraideh et al. (2017) and Chaudhuri et al. (2021) investigate the relationship between SCM, Technological Innovation, and ECRM, aligning with H6. Ghosh et al. (2020a) and Chatterjee et al. (2021) examine the interplay between Business Management, Technological Innovation, and ECRM, supporting H7. Hizam-Hanafiah and Soomro (2021) and Rydell and Suler (2021) discuss the impact of Production Development, Technological Innovation, and ECRM, which is in line with H8. Lastly, Poita et al. (2022) and Pozza et al. (2018) explore the relationship between Strategic Management, Technological Innovation, and ECRM, aligning with H9. These studies collectively provide a strong foundation for the hypotheses proposed in this research.

The existing study is free from prejudice in light of the clarifications above. Consequently, the findings derived from both the context of this research and preceding studies boast a high level of reliability. Furthermore, these outcomes align consistently with the results of prior investigations.

## 5.4. Practical suggestions

Based on the results obtained from the research and theoretical foundations, considering that the examples of studied projects are industrial projects in the form of EPC and large projects, the following suggestions are proposed:

In order to carry out installation, implementation, testing, and start-up work in industrial projects, the use of updated modern machines and calibrated technologies can help a lot in doing work more easily and accurately, and this will prevent or minimize time delays and unforeseen costs. By developing and updating specialized software in the departments of

design, research, and development (R&D), and testing and commissioning, it is possible to increase the level of progress and accuracy in the relevant matters and estimate better equipment for ordering and purchasing.

By managing data and forming working group meetings and consensus with all relevant specialists, a systems integration can be created to provide more accurate feedback from technology in the R&D department with Re-Engineering. By using the smart and digital supply chain, a more coordinated and integrated connection can be created between the production, transportation, and production sectors so that delay times and profitability can be maximized.

The information collected from customers mentioned as employers and shareholders in industrial projects allows us to understand their needs and demands transparently. Additionally, relationship management with them can be helpful in direct communication with employers, receiving their up-to-date needs, and creating an intelligent network to integrate information.

Product development and production need to provide different distribution channels and workflow designs for communication between these two processes. With the related training of the production personnel, the risk of errors and mistakes is reduced, and the technical procedures and the production process are optimized. All these matters are provided by a skilled and professional product production manager who is the leader of the production team. Compliance with the laws of production and quality of materials and the environment and awareness of environmental laws help in the field of better product quality. Therefore, the better the quality of the product, the more satisfied the customers are, and based on that, there will be more sales and profitability.

Business management through creative and innovative technologies can have a positive effect on the company and project process. Creating a coordinated and intelligent network in order to recognize the shortcomings of the market and communication between clients (employers, owners, contractors, manufacturers, consultants-Known as customers) of projects can be a migration from traditional methods to modern methods. Knowing the needs of the company and the project, coordination between the design, purchase, and execution units, as well as the communication between the company and the producers, can reduce the costs drastically and promote the company at the national and global levels.

Smart and efficient supply chain management can be a very important intermediary between production and customer management. Machines with high production technology and good quality can cause customer satisfaction, and with an ECRM system, the amount of feedback and efficiency can be collected in the market. The supply chain close to each producer and its distribution market can provide faster communication and distribution, and naturally, the costs are greatly reduced, and it offers better improvements according to the market needs. Operational, structural, and analytical management can establish stronger, more precise, and innovative relationships in the market and among projects. By integrating more efficient business management with previous management practices, a more coordinated and knowledgeable approach to the market can be achieved, thereby meeting the needs of employers and contractors. As a result, the company can become more profitable, reduce costs, improve targeting, increase brand recognition, and establish itself as a national and global brand.

Normally, industrial projects start with the proposal-design-build method, which means that first, the industrial needs are recognized by the employers, and they are proposed to the customers to fulfill them. The design suggestions are made by the contractors and after the approval of the design, they enter the construction phase, to be installed and started after that. Therefore, every project has the main factor of cost and time. Therefore, having an advanced and precise product development and production system with minimal errors can reduce many problems and prevent them from occurring.

By intelligently managing product development and establishing a connection between production technology and customer demands, the priorities of projects (i.e., customer priorities) can increase production capacity and provide stability in the production process. Effective management of customer demands can directly impact both technological innovation and electronic customer relationship management (ECRM), thereby preventing the need for remaking or reformulating production. Thus, the direct relationship between customer demands and their management can enhance technological innovation and ECRM. Various trends can be taken into account to establish the required strategies for the company and organizational goals, as well as projects, and to develop a successful ECRM system. In the initial stage, creating a network of key relationships is crucial. By creating information and data management from employers, contractors, market needs, and customers, problems can

be classified, and as a result, more practical solutions can be provided. By generating an effective and efficient system in international relations and the national and global markets, it is possible to identify new markets and advance in the direction of global cooperation. In the second stage, analysis and activity have been created in communication channels. Customers' processes can be managed by identifying customer groups and making decisions in communication. It means that by understanding the needs of the market and customers and clarifying these needs for customers, it is possible to step into the leading market by satisfying their demands.

According to the creation of the need in the second stage, in the third stage, the factors such as the required suppliers, various types of services such as the supply chain, transport and production, and the required standards were identified, and in the field of cooperation or creation, it provided the necessary resources and support. In the fourth stage, he identified the priorities of the customers, and by creating a smart and strong ECRM network, sales and distribution networks, the markets of the customers' needs, and the necessary gaps were met.

## 5.5. Limitations of the research

The current research was faced with the following limitations:

### 5.5.1. Limitations of theoretical foundations and research background

The current study's limitations include a scarcity of research on the variables of the research model in foreign universities that have measured the relationships between Technological Innovation, Production Development, ECRM, Strategic Management, Supply Chain Management, and Business Management. Despite the fact that there have been many studies in this field, few studies have focused on the relationships between these variables, such as the mediating role of Supply Chain Management, Business Management, and Production Development, as well as the moderating role of Strategic Management. As a result, much research should be carried out in this field to examine and evaluate the relationships between these categories of mentioned variables.

### 5.5.2. Time limit

The data collected in the present study were collected in a short-term period and cross-sectionally from two qualitative and quantitative sources.

A significant limitation was the time constraint for gathering information from project personnel. This was due to various factors such as their busy schedules in different parts of the project, absence from work, simultaneous involvement in project activities, lack of access to personnel, lengthy coordination efforts, and limited availability for question and answer sessions. Additionally, organizational bureaucracy and the complexity of collecting data from people in various ways further complicate this process.

### 5.5.3. Limitation of the cost

Due to the lack of written documents and the non-uniformity of the processes of each project, it is difficult to estimate indirect costs. Most people are not able to identify the various costs of the project. For example, the repetition of processes is normal in the opinion of most people, but from the point of view of management, these cases lead to the reproduction and repetition of the process, and as a result, an unexpected cost (less than before) has been applied to the project.

Any type of delay in a part of the project leads to an increase in costs, so it is practically impossible to estimate indirect costs for the medium or long term. Costs caused by lack of man-hours in design, reproducing a product or process, unforeseen defects in process processes, and costs caused by natural disasters and environmental forces can lead to cost imposition at any stage of the project.

### 5.5.4. Limitation of the statistical population

This model has been designed and implemented for a sample project in the oil industry and in the transport sector, and caution should be taken when generalizing it to other related industries and projects.

## 5.6. Recommendations

In the present study, the interview tool was used in the qualitative section, and the questionnaire was used using a Likert scale, in which respondents had to answer the

questions based on predetermined closed answers, which in turn can limit people's views in relation to a specific phenomenon. Therefore, it is suggested that other methods, in addition to the questionnaire method, be used in order to check the relationship between the variables of the current research; for example, observation methods and content analysis to analyze real data can make the research results more reliable.

Therefore, it may be possible to solve problems by adding a solution to increase the statistical sample, which in turn is costly and time-consuming.

According to the progress of the PLS-SEM method in recent years and the above explanations, a step-by-step method for improvement and standardization is proposed:

- Creating a general model and formulating hypotheses and theories:
  Previous research and samples can be utilized to examine prior studies through a literature review. According to the above contents, the necessary presuppositions and hypotheses are modeled, and an initial model is obtained.
- Creation of Datasheet and Specification for tools and methods of measurements:
  One of the measurement tools is PLS-SEM, which can be used to measure the researched items with SmartPLS software. The more up-to-date the method used, the more accurate the calculations will be.
- Collecting, categorizing, and grouping all data and information obtained:
  One of the most important aspects of the studied statistical community is its extent and diversity. Different methods can be used to collect data and information. Demography, typology, statistical sample framework, and the extent and consensus of the data can be investigated. Contradictions, heterogeneity, integrity, and volume of data can be estimated.
- Model analysis and data extraction for initial evaluation:
  According to the third chapter, Validity, Reliability, External and internal models, Reflective and formative models, Variance-based, etc., can be used as examples.
- Data Analysis:
  $R^2$, $F^2$, $Q^2$, T-Value, Cronbach's alpha, and GoF include various tests, and the most basic indicator for measuring the relationship between variables in the model (structural part) is more significant numbers.
- Information output and comprehensive report:

Calculations with details, results obtained, generalizability, and future suggestions should be presented in the final report. Findings and steps to access it should be included in the report so that they are understandable.

## 5.7. Future Research Opportunities

The rapid advancement of technology and information presents numerous opportunities for future research. Every day, new and innovative technologies are utilized to execute a wide range of projects worldwide, primarily aiming to reduce time and costs in the context of industrial ventures. Having the necessary information from customers, managing relationships with them, and meeting their demands in various industrial projects are the factors of concentration in each project. Industrial projects such as the oil and gas industry, petrochemical industry, refinery, urban and suburban subway (metro), inter-urban and country railway, construction industry, raw material manufacturing industries, pharmaceutical and chemical industries, etc., can be the subject of future research.

Other suggestions for expanding the research could include extending the study to a larger project, investigating a more complex case study, and researching a project in a different and more specific location, city, or country. Identification of other factors involved in the sample of special projects, production of special equipment or samples, production of special products and processes, and more and larger sampling with more data collection methods can help in future research.

Using the PLS-SEM method, which is a more promising and useful method, can be a more accessible and useful tool to guide researchers in the direction of developing a sustainable solution. This method has made good progress in recent years, extremely helpful at the organizational and company levels, and can be considered one of the practical methods in the field of communication with customers. Due to the fact that these relationships are formed from the point of view of experimenters and perceptions and opinions, this is a suitable method to turn it into a tool for measurement.

Among the proposals that can be emphasized for its expansion in the future is the field of research in the direction of artificial intelligence (AI). In this regard, research on AI-CRM and AI-ECRM have the potential to make significant progress and will be one of the strong

suggestions in the near future that will make the needs more accurate and bring the relationships closer together.

## 5.8. Summary

In Chapter 1, there is an overview of the main motivations of organizations and companies, their main challenges, and their problems. Research hypotheses, models, and research objectives were stated, and a conceptual model was determined. PLS was discussed, and the structure of PLS-SEM was explained. It was explained that SEM is a multivariate data analysis and processing method that is often used in the fields of engineering and data information. The types of variables, latent variables, endogenous variables, and exogenous variables were defined. The types of indicators that are divided into inner and outer models in SEM were explained.

There are two types of measurement in SEM, which are divided into two types: Formative Measurement Scale and Reflective Measurement Scale. Explanations were provided regarding multivariate methods. PLS-SEM is used by researchers as a forecasting method that is being developed. In the Partial Least Squares (PLS) technique, effect size index $F^2$, determination coefficient $R^2$, $Q^2$ index, and Goodness of Fit (GoF) statistics are usually used. Structural model fit evaluation indices: In order to fit the structural model, the following evaluation indices were performed in order: T-Value, $R^2$ index, $Q^2$ index, and Redundancy index. Formulations and acceptable intervals were determined, and then SmartPLS and its concepts were explained. Redundancy index, cronbach's alpha index, and rule of thumb for results cronbach’s alpha were used for calculations. In the end, influencing factors and model components were identified.

In Chapter 2, prior studies and literature in the relevant fields were reviewed, and previous works and examples were incorporated into the main objectives and hypotheses of this research. This history is about electronic customer relationship management, strategic management, supply chain management, business management, product development and innovation, decision making, employees, customer behavior, market requirements, and customer satisfaction, in line with the needs, structure, goals, and knowledge of the projects.

In Chapter 3, the research method, its components, the introduction of the used methods, and its features were discussed. The framework of the study was introduced in general to

create a vision for doing things. Regarding the stage of research, explanations were provided, including five (5) stages, which include hypotheses, model, objectives, methodology, literature review, background, design, collect, analyze, test the hypotheses and information model, analysis results, and conclusion about hypotheses. Then, explanations were given about the types of research used here, according to application: strategic basic research and experimental development, according to objectives: descriptive research and exploratory research, according to strategies: mixed strategies (quantitative and qualitative strategies): concurrent mixed methods.

Strategic basic research was used, the relevant explanations were specified, and mixed strategies that include qualitative and quantitative strategies were considered. Combined concurrent and transformative methods are used for research on the subject. The characteristics of experimental development were presented, and descriptive and exploratory research descriptions were provided. All the aforementioned cases were described in accordance with the users' needs. These methods were clearly explained, and the type of their usage was investigated.

Quantitative research and qualitative research methods were mentioned, and the difference between them was presented; these methods were carried out in the process of this research. Information and data collection systems and how to use them were explained. Location of researches, subject of research, research resources (data source), and project documentation were mentioned for examples of industrial projects, and the types of interviews used were included. Various questionnaires and surveys have been considered for interviews with main managers, mid-level managers of organizations, and experts and specialists. Survey and interview methods are used: face-to-face, mail, internet, online (Skype,…).

Introduction of variables and their operational definitions: variance-based approach or Partial Least Squares (PLS), the sample size in the PLS partial least squares method, reflective measurement models (reflective), and combined models (formative). Assessments of the Measurement Models were described as an assessment of the outer model: reliability and validity, assessment of the internal model, and assessment of the PLS model. According to the formulation, modeling, calculations, and measurements, the allowed intervals in applying the obtained results and the evaluation criteria of the measurement model were specified. In the end, explanations were given about the case studies. The variables, checklist for details of

problems, time scheduling and work structure, budgeting, and expenses were the problems identified for these projects after reviewing the necessary documents.

In Chapter 4, demographic characteristics were described which were including:

Research location: Among the 385 persons in the statistical sample, 187 persons, equivalent to 48.6%, were at the research site of the Project in the Oil industry, and 198 persons, equivalent to 51.4%, were at the research site of the Project in the Transport sector.

Gender: Out of 385 statistical samples, 73.8% (284) were men and 26.2% (101) women.

Age: 19.7% (76) are 20-35 years old, 34.5% (133) are 36-40 years old, 23.1% (89) are 41-45 years old, 15.6% (60) are 46-50 years old, and 7.0% (27) are over 50 years old.

Education: 22.3% (86) have a bachelor's degree, 38.7% (149) have a master's degree, and 39.0% (150) have a doctorate.

Organizational levels: 89 persons, equal to 23.1%, are experts; 120 persons, equal to 31.2%, are in engineering organizational positions; 75 persons, equal to 19.5%, in the position of the department manager; and 32 persons are equal to 8.3% of engineer management. 33 persons, equivalent to 8.6%, were found in the position of project management, and finally, 36 persons, equivalent to 9.4%, were found in the position of site/location management.

Then, after the introduction of this part, the research model was analyzed, the external loads for the conceptual model of the research were described, and measurement and structural models were presented in the SmartPLS 4 software. The fit of the measurement model was presented, which includes Reliability: Cronbach's alpha values, the combined reliability values of the research constructs, Convergent validity: the results of average variance extracted (AVE) for research constructs, and conceptual research model with path coefficients and external loads was shown. Structural model fit (divergent validity, fornell-larker matrix), conceptual research model with t-values, coefficient of determination ($R^2$ value), $Q^2$ forecasting criterion and predictor fit, and Overall model fit were calculated. After that, research hypotheses, mediation, and moderation in PLS-SEM were examined, and the results that were obtained were included.

In Chapter 5, at the beginning of entering the statistical analysis section, the components of the proposed model were first extracted with a qualitative method and based on the algorithm presented in the fourth chapter, the model was validated, and after ensuring the appropriateness of the models, the relationships between the variables were checked.

In short, all significant relationships were observed, and in other words, among the nine hypotheses, all relationships were confirmed with a significance statistic value above 1.96 at the 95% confidence level. Three mediating roles have been accepted by the variables production development, business management, and supply chain management, and the moderating role of strategic management has also been confirmed.

Research findings, including descriptive findings and inferential findings (hypotheses test results), were determined, and the results were described for each of the hypotheses. In the end, practical suggestions and limitations that existed in this research were mentioned. After that, recommendations, opportunities, and topics that can be researched in the future were determined.

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# Appendix

*Appendix*

## Sample questionnaire:

**LOCATION OF RESEARCH:**

Project A: Combined Cycle Power Plant, Country: Iran ☐

Project B: Urban Railway Metro, Country: Iran ☐

**SEX:** Men ☐ Women ☐

**AGE:** 20-35 ☐ 36-40 ☐ 41-45 ☐ 46-50 ☐ over 50 ☐

**EDUCATIONAL LEVELS:**

Bachelor ☐ Master ☐ PhD ☐

**ORGANIZATIONAL LEVELS:**

Expert ☐ Engineers ☐ Department manager ☐ Engineer Manager ☐ Project manager ☐ Site Manager ☐

| No. | DISCRETIONS | ABSOLUTELY DISAGREE | DISAGREE | NEUTRAL | AGREE | ABSOLUTELY AGREE |
|---|---|---|---|---|---|---|
| 1 | Modern technology makes work processes to be done on time. | | | | | |
| 2 | Application software development is effective in the rapid process of design. | | | | | |
| 3 | Systems integration has a direct effect on project control in management. | | | | | |
| 4 | Project management can be concluded by Data Management | | | | | |
| 5 | Systematic thinking is effective in optimizing project affairs. | | | | | |
| 6 | Re-engineering in project matters reduces cost and time. | | | | | |
| 7 | Failure to understand the need for change is one of the causes of delays in work. | | | | | |
| 8 | Technological innovation is a threat to job security. | | | | | |
| 9 | Lack of necessary cooperation and coordination between universities and higher education institutions with companies causes inefficiency in the process of activities. | | | | | |
| 10 | Environmental laws are one of the effective factors in product development. | | | | | |
| 11 | According to the location of the projects, the need for different distribution channels is one of the cost-reduction factors. | | | | | |

*Appendix*

| No. | DISCRETIONS | ABSOLUTELY DISAGREE | DISAGREE | NEUTRAL | AGREE | ABSOLUTELY AGREE |
|---|---|---|---|---|---|---|
| 12 | Lack of membership in commercial groups causes a lack of effectiveness in product development in the market. | | | | | |
| 13 | It is not possible to coordinate the product development chain without creating a precise Workflow design. | | | | | |
| 14 | Lack of adaptability and willingness to maintain technical procedures prevents progress in production development. | | | | | |
| 15 | Lack of risk prediction and lack of necessary training increases the risk of failure. | | | | | |
| 16 | The existence of an inefficient and unskilled leader and dissatisfaction with the leadership causes a decrease in the production process and development. | | | | | |
| 17 | Not having enough skills directly affects the lack of success in product development and production. | | | | | |
| 18 | The traditional and inappropriate structure in companies does not match with the company's structure. | | | | | |
| 19 | Identifying the market and designing products according to customer needs causes product development. | | | | | |
| 20 | Lack of quick access to producers and lack of new materials are the causes of lack of growth in the market. | | | | | |
| 21 | The inability to understand the target market and changing capital markets causes a lack of progress in the supply chain. | | | | | |
| 22 | Failure to correct and identify the inefficient distribution and transportation system causes defects in the supply of goods. | | | | | |
| 23 | Without having a precise and targeted plan and hastiness in providing services and products, supply chain management will fail. | | | | | |
| 24 | Not having enough skills in identifying the supply factors makes the supply chain less efficient. | | | | | |

*Appendix*

| No. | DISCRETIONS | ABSOLUTELY DISAGREE | DISAGREE | NEUTRAL | AGREE | ABSOLUTELY AGREE |
|---|---|---|---|---|---|---|
| 25 | Lack of expert forces for proper risk assessment causes disruption in supply chain performance. | | | | | |
| 26 | Change in social, cultural, and industrial values in the investment market has caused new demands. | | | | | |
| 27 | By knowing and studying the lack of market integration, useful solutions can be created in business management. | | | | | |
| 28 | Tax policies and tariffs have a direct effect on business and progress in all markets. | | | | | |
| 29 | The structure and distribution of projects, population and its growth, and dispersion of industries are direct factors in understanding the markets. | | | | | |
| 30 | Presence in global markets is a profitable and challenging goal. | | | | | |
| 31 | Roles and relationships are one of the determining factors in the success of business management. | | | | | |
| 32 | One of the main goals is to pay attention to the need for the company's rate of return. | | | | | |
| 33 | One of the costs and time-consuming factors is switching costs and moving between different types of markets and projects. | | | | | |
| 34 | In more traditional societies, one of the determining factors of some markets is social relations and traditions. | | | | | |
| 35 | Determining the type of strategic management of relations with customers is the road map of the work process. | | | | | |
| 36 | Determining the type of operational management of relations with customers is one of the operational factors of the project. | | | | | |
| 37 | Determining the type of structural management of relations with customers is one of the determining factors of frameworks before starting any project. | | | | | |

*Appendix*

| No. | DISCRETIONS | ABSOLUTELY DISAGREE | DISAGREE | NEUTRAL | AGREE | ABSOLUTELY AGREE |
|---|---|---|---|---|---|---|
| 38 | Determining the type of Analytical management of relations with customers is one of the most basic feedback items from the results and during the project process. | | | | | |
| 39 | Getting new relationships is necessary for the progress of the company, to make it better known, and to attract new projects. | | | | | |
| 40 | Strengthening relationships with project agents and employers is necessary to survive in the new market. | | | | | |
| 41 | Maintaining current relationships and their continuation in the direction of greater profitability is one of the most important factors in customer relations. | | | | | |
| 42 | Customer information management and classification of obtained data reduce costs and schedules. | | | | | |
| 43 | Decision-making about solving the limited problem is one of the factors in maintaining relations with dissatisfied customers. | | | | | |
| 44 | Testing the efficiency of the system at each stage of the project and in specific schedules prevents the waste of the project process. | | | | | |
| 45 | By providing initial samples, the existing market can be tested for profitability. | | | | | |
| 46 | Creating the type of communication channels during the project can be done by Management of customer processes. | | | | | |
| 47 | If a big problem is identified in the system, decision-making about solving a broad problem in line with the goals of the company and the customer will strengthen the previous relations. | | | | | |
| 48 | Customer grouping is one of the key factors regarding the type of communication and customer-oriented culture. | | | | | |
| 49 | Identifying the needs of each customer with the method of customer experience standards can determine the type of service provider. | | | | | |

*Appendix*

| No. | DISCRETIONS | ABSOLUTELY DISAGREE | DISAGREE | NEUTRAL | AGREE | ABSOLUTELY AGREE |
|---|---|---|---|---|---|---|
| 50 | Deciding on the solution to the assigned problem (routine) can change the type of goods and services. | | | | | |
| 51 | Before starting any activity, Value-creating factors for services should be determined and valued. | | | | | |
| 52 | Value-creating factors in the relevant industry are identified and included in the service and goods. | | | | | |
| 53 | Modification and review in the sales and service section have a direct effect on the relationship with customers. | | | | | |
| 54 | Valuing the demands of users can improve the quality of customer satisfaction and services. | | | | | |
| 55 | Determining and finding value-creating factors for customers has an effect on customer service. | | | | | |