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Technology and Management Comprehension in the Age of Digitalization

Editor: Doç. Dr. Gönül Yüce Akıncı

ISBN: 978-625-372-036-0

Page Layout: Gözde YÜCEL
1st Edition:
Publication Date: 25.12.2023
BIDGE Publications,

Certificate No: 71374

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Krc Bilişim Ticaret ve Organizasyon Ltd. Şti.
Güzeltepe Mahallesi Abidin Daver Sokak Sefer Apartmanı No: 7/9 Çankaya / Ankara

PREFACE

Business management, which dates back to the first reflections of modern man, reached an important turning point with the first Industrial Revolution, the foundations of which were laid in the 18th century, and reached today's modern understanding with the scientific management approach put forward by Frederick W.Taylor. This understanding has shaped efficient production and effective resource management based on the modern business process that allows complex business processes to be analyzed with scientific methods.

In recent years, radical changes and transformations have been experienced in both social and business life with modern approaches. Rapid developments in information and communication technologies, which are considered as the most important source of competition, have significantly affected the managerial structures, business processes, basic technologies and human relations of organizations. Effective management and organization systems, which are the source of these effects, have been one of the pioneers of the scientific revolution and technical breakthroughs have formed the general framework of business management and optimal organizational structure today. Within this framework, the effective use of scientific knowledge, digitalization, orientation towards innovative activities, optimum use of artificial intelligence, acceleration of human capital accumulation, and in parallel with this, the transition of the gold-collar class to a leading position in the social structure has witnessed a total change and transformation of the business management and organization structure. In this context, in the business management literature, issues such as placing total quality management on a sustainable basis, bringing efficiency to the forefront in management and organization thinking, the use of artificial intelligence on the basis of organization and the evaluation of the moral consequences it will create, and the effective use of knowledge and wisdom in organizational systems have been brought to the forefront.

Therefore, the issues mentioned in this work have been discussed and analyzed in detail. In other words, in the first part of

the book, the features of Software Infrastructure in Smart Factories in the Digital Transformation of Businesses written by İsmail YOŞUMAZ will be examined, and in the second part, machine learning processes will be discussed with the work of Ayşe SALMAN. The third part of the book, written by Melike ARTAR, Yavuz Selim BALCIOĞLU and Oya ERDİL, will be the scene of discussions on the future of enterprises and in this context, the example of digital employees will be examined. In the fourth chapter contributed by Melike ARTAR and Oya ERDİL, the impact of workplace attachment style on work behaviour will be highlighted and the last chapter will be devoted to the elaboration of the concepts of innovation and consumer innovation examined by Reha SAYDAN, Bulut DÜLEK and Uğur TATLI.

Undoubtedly, the field of management and organization includes a wide range of theoretical and applied studies. However, the main purpose of this work is not to examine the relevant theoretical and applied researches in a holistic manner, but to examine the issues that are prepared on the basis of a certain framework and fall within the field of management and organization. In this context, I would like to thank all the authors who contributed to the creation of the work for their efforts and express my gratitude to Bidge publishing house and its team for their contributions.

I hope that the work will contribute to all researchers, industry experts and readers interested in the subject.

Editor
Assoc. Prof. Gönül YÜCE AKINCI

Ordu University

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CHAPTER I

Features of Software Infrastructure in Smart Factories in the Digital Transformation of Businesses

İsmail YOŞUMAZ

Introduction

Smart factories operate based on data and information, with cooperation between technology and the internal and external environment of the enterprise. These factories manage all processes with specific software, which are often sourced from multiple manufacturers due to the challenges of using a single manufacturer's software to manage the entire factory. The purpose of this study is to provide an objective overview of software features that are applicable to smart factories. The study will employ a clear, logical structure with minimal complex terminology to ensure comprehension and flow of information. The study aims to describe the software features that are relevant to smart factories without disclosing any manufacturer-specific information. The language will

be formal and objective with a neutral tone, adhering to conventional academic writing standards and using precise technical vocabulary where appropriate. Additionally, the study will follow recognised formatting and citation styles, maintaining grammatical accuracy at all times. However, if necessary, reference to specific manufacturer software may be made. As a standard for naming the software, preference is given to open-source options.

1.From Single-Sided Automation to Double-Sided Automation: Smart Factories

James Watt's discovery of the steam engine in the 1700s sparked significant transformations in production methods and consequentially in other aspects of businesses. Following the invention of steam machines, further advancements in technologies like electricity and telephone occurred, which established the onset of the factory system. Essentially, the introduction of automation into factories has facilitated the automation of heavy and continuously repetitive manual labour. A one-sided era of automation has commenced in factory processes. Put differently, machines have begun emulating humans by processing information received, allowing for just-in-time processing.

The widespread adoption of wireless communication technologies, the transition of sensors from analogue to digital, and the ability to efficiently transmit data to storage systems, has enabled faster analysis of transmitted data. By incorporating technology into factories, such data analysis can inform the feeding of technologies concurrent with the rapid growth in mobile internet usage. The evolution of technologies including artificial intelligence and cyber-physical systems has facilitated automation's shift towards two-sided perspectives. In other words, information, data and knowledge flow not only from humans to machines, but also from machines to humans. Consequently, factories have become more efficient than before by incorporating this functionality. These functional factories are commonly referred to as smart factories, but it is important to note that the term smart does not necessarily imply a level of

autonomy. Smart factories are cooperative systems that integrate technology, employees and other units using data and information. The degree of autonomy in these systems determines the illumination level of the factories. A fully autonomous factory can turn off the lights, creating a "dark" factory. Technical abbreviations will be explained upon first use. Word choice will be precise and free from grammatical errors or punctuation mistakes. A formal register with balanced, objective language will be maintained. Contractions, colloquial language, informal expressions, and unnecessary jargon will be avoided whenever possible. This analogy, utilizing the concepts of darkness and "lights out," is directly proportional to the level of autonomy. Biased language and emotional evaluations will be excluded unless clearly marked as such. This analogy, utilizing the concepts of darkness and "lights out," is directly proportional to the level of autonomy. Citations will adhere to the designated style guide and quotes will be clearly marked. The structure of the text will progress logically, with causal connections between sentences and paragraphs. It can be stated that the degree of darkness corresponds to the degree of autonomy, i.e., the higher the autonomy level, the greater the darkness level, and vice versa.

The progress in automated machines and software for production operation management has led to the emergence of dark factories, including dark production cells for specific production stages. By incorporating fully automated production processes, such software is competent in managing them and ensuring the traceability of autonomous production processes. (*What Is a Lights-out Factory | Siemens Software*, n.d.).

Factories with a high level of autonomy can be easily implemented for simple mass production of a standard product according to a fixed schedule. As products become more complex and mass customisation creates a large number of product variants, a completely dark (autonomous) factory becomes more difficult, but not impossible.

The technology that makes products visible in a dark factory (in autonomous production) is digital twin technology. Thanks to this technology, every process from production to customer use of the product becomes virtually visible (can be tested and planned).

2.Software Infrastructure in Smart Factories

Software infrastructure in smart factories requires a range of programs and technologies to collect and manage data, analyze it, uncover new insights, and share information. This infrastructure encompasses a vast array of components. Software infrastructure is employed in areas such as operational technologies (including production, maintenance, and supply) and information and communication technologies (such as accounting and finance) as well as employee tracking. Examples of software that can be utilised in smart factory infrastructure include e-mail software, artificial intelligence technologies, CRM software, automation software, and internal software of machinery and equipment (e.g. embedded systems). For the software infrastructure in smart factories to operate effectively, it is essential that the software has the ability to cooperate with one another. The factories can develop this software themselves or acquire it through local servers and data storage systems or cloud computing technologies. Smart factory management software is the term used to describe software that facilitates this cooperation. These programs are also known as ERP software in the industry.

Smart factory management and monitoring software, which allows for cooperation between the different applications used in the smart factory, should possess the capability to manage and monitor all factory processes. However, locating such software is challenging due to the numerous distinct processes involved in smart factories. It is difficult to consolidate all these processes into a single software solution from a single manufacturer. Consequently, various manufacturers code software for smart factories to perform different tasks. For instance, CAD/CAM software is utilised to create a virtual model of a product during production, MRP software is employed

for material planning during production processes, MES software executes production procedures, CMSS software is used for machine and equipment maintenance, and production analytics software can coordinate with ERP or CMSS software. Numerous manufacturers have developed solutions for these types of software.

Smart factory management software should generally include the following features (Copadata, 2023):

a) Data collection
b) Decision support as a result of data visualisation and data analysis
c) Process Management
d) Cyber Security

2.1.Data Collection

Data can be collected from two distinct components: physical systems and employees. Data collection from physical systems involves acquiring information from internal and external data sources of an organization, using relevant sensors and software. Data collection from employees refers to the practice of gathering data from personnel through sensors, artificial intelligence systems, and software that conduct behavioural analysis. Technical abbreviation explanations are provided as needed.

a.Data Collection from Physical Systems

In order to analyse the data and obtain valuable information, the data must first be obtained. Obtaining data depends on the identification and collection of data sources. Data sources are basically divided into two groups. The first is internal data sources and the second is external data sources. Internal data sources can be all objects within the factory. Everything that can produce data such as people, machinery, equipment can be considered in this context. External data sources, on the other hand, can be the government, social media, data archives (such as open data archives), feedback

from customers, data on the use of the products purchased by customers. After the data of both groups are analysed individually or correlationally with different data analysis methods, valuable information emerges. This valuable information becomes an input for each unit in the factory. These inputs are the determinants of what needs to be done in the processes within the factory. For example, if a company that manufactures automobiles follows the parts coming from its supplier from the production line of the supplier and shapes its own production, it will cause the production processes of the automobile manufacturing company to continue without interruption.

Strategies for collecting data from both internal and external sources may be different. For example, in order to collect data from external sources, data and information can be accessed through the API infrastructure with the software used in external sources. API infrastructure is not the only way. Even without API, data from external sources can also be obtained through data transfer tools such as database files, csv (comma separated value), xml.

b.API Infrustructure

Developing intelligent factory management software bears resemblance to developing an operating system which is similar to utilizing the deductive method in mathematics. For instance, Microsoft has formulated the Windows operating system, on which other software manufacturers have developed programmes to run. Nowadays, developing smart factory management software is comparable to utilising the inductive method. The software under development must be capable of interfacing with various smart factory infrastructure software. For this purpose, software technologies typically utilise a mechanism known as an Application Programming Interface (API). APIs establish communication between two software components using a specific set of protocols and definitions. (Amazon Web Services, 2023).

1.Data Transfer Tools

Data transfer methods can vary depending on the software used. These tools facilitate the transfer of external source data to internal software. The most widely used methods are database files, CSV (comma separated value) files, and XML (extensible markup language) files. These tools facilitate the transfer of external source data to internal software.

2.Internet of Things (IOT)

The concept of the Internet of things encompasses the ability of all kinds of objects, such as computers, phones, machines, sensors, humans, and animals, to send data to the network via wired, wireless, or mobile infrastructure. (Gills, 2022). Sensors on a dishwasher that send a wireless notification to the owner's mobile phone once the program completes, or a machine in a factory that transmits vibration data to relevant systems every 3 seconds through its connected wired or wireless network, can be considered as part of the Internet of Things.

The benefits related to IOT Systems and the issues to be considered can be summarised as follows.

Benefits	Considerations
Automating Processes: By analyzing the data acquired, it facilitates the development of the required infrastructure for the automation of all processes in the factory.	**Cyber Security:** As the number of connected devices increases and more information is shared between devices, the potential for a hacker to steal confidential information increases.
Traceability: Allows remote monitoring of objects connected to the system.	**Infrastructure Management:** Organisations may eventually have to deal with large numbers or even millions of IoT devices, and collecting and managing data from all these devices will be challenging.
	Standards: Since there is no international compatibility standard for IoT, it is difficult for devices from different manufacturers to communicate with each other.

Table – 1: Benefits and considerations of IOT systems (Gills, 2022)**.**

In general, an IOT system requires three distinct components for efficient functioning. The first component is comprised of tools which facilitate data collection. Examples of such tools include sensors and RFID antennas. The second component consists of structures known as IOT Hubs or Collection Points, that classify incoming data and transmit it to the system where it is analysed. These structures may be in the form of software that runs on a cloud or a local network. Thirdly, these structures are where IOT data undergoes analysis and the resulting findings are shared with the necessary systems or users. (Gills, 2022).

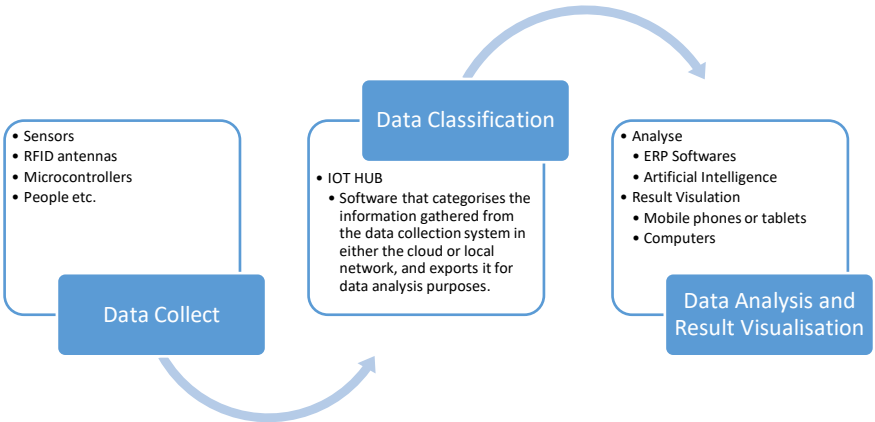

Figure -1: Internet of Things Working Principles (Gills, 2022)

Although the term IOT is commonly used, technologies implemented in industrial systems are referred to as IIOT, which stands for Industrial Internet of Things. A table below illustrates the distinctions between IOT and IIOT. (Priya, 2022).

Differances	IOT	IIOT
Cost	Since the sensitivity of IOT devices is less important than IIOT, costs are lower.	Costs are higher.
Complexity	IOT applications are simpler than IIOT.	IIOT applications are more complex than IOT.
Aim	Consumer convenience is used for purposes such as managing the devices used by consumers.	Data analytics, health, aviation, energy, production, etc. It is used in the performance of tasks such as collecting data from objects working in sectors such as health, aviation, energy, production, etc., and giving them the ability to act interconnected with each other.

Table – 2: Differences between IOT and IIOT (Priya, 2022)

a.Collecting Data from Employees

Collecting data from employees is not like collecting data from physical systems. Physical systems are tasked with fulfilling what is commanded to them. However, employees have external factors that can affect the data collection infrastructure such as their emotions, thoughts, wishes, and wishes.

Data can be collected from employees in different categories such as clocking in and out (overtime tracking), location at work, performance data (Fallon, 2023), internet usage data, health information, personal data of employees collected by human resources. While utilising these data, it should be kept in mind that it is necessary to have an infrastructure in accordance with the laws of the countries regarding the protection of personal data.

Collecting data from employees is generally important for businesses where manual labour is intensive. Because in enterprises where manual labour is intensive, the rate of machine usage may be low. For this reason, in order to obtain both their own performance and the number of products they produce related to the work done by the employees, data can be obtained from the employees through tablets, computers, mobile communication tools, data collection software to be developed by the enterprise or ready-made data collection software produced by a manufacturer.

b.Internet of Behaviours

The concept of the internet of behaviour entails acquiring, analysing, modelling, extracting, and controlling data related to human behaviour. This is achieved by gathering and processing requisite information.(Ramos, 2023; Thomas, 2022). Data collection is imperative towards understanding people's attitudes in behavioural activities, including social media, health service usage, and shopping behaviours. The insights garnered from the data collected can guide organisations in their marketing, service, and healthcare provisions (Thomas, 2022). The aforelisted technologies, including artificial intelligence, machine learning, internet of things, wearables, augmented reality, and virtual reality, are employed to carry out these tasks. (Ramos, 2023). For instance, due to the presence of a sleep tracking feature in a smartwatch, data concerning when an individual wakes up, the quality of the undisturbed sleep, and other relevant metrics are transmitted via Bluetooth from the watch to a mobile device. Then, the data is further analysed on a storage system using software where necessary results and recommendations are reported to the user after careful examination.

Thanks to the Internet of Behaviours, by collecting data on customer preferences, habits, and trends, companies are able to identify a specific target audience for advertising. Through necessary data analysis, appropriate advertising activities can be planned and executed. If a photograph of the meal consumed at a dining establishment is captured and subsequently uploaded to a

social media website intended for sharing similar images, it is plausible that an artificial intelligence program could analyse the contents of the meal and identify what was consumed and imbibed based solely on the photo. If coffee was not consumed during the meal, a notification such as "Coffee complements a meal. Your coffee is 25% off today" can be sent to the customer while passing by a coffee shop, potentially influencing their preferences.

The internet of behaviours is believed to be a crucial determinant of the Industry 5.0 process. In essence, the Industry 5.0 process can be concisely explained as a new phase of industrial revolution. (European Commission, 2022):

Industry 5.0 = Industry 4.0 + Human (Employee or human) + Environment + Resilience

There is a significant relationship between the concept of human and the internet of behaviour in this formula. Although the human concept was addressed in the Industry 4.0 process, it was not given as much importance as a machine. Therefore, it can be understood that in the Industry 5.0 process, in addition to the resilience of the environment and businesses against threats, there may be expansions on humans and human intelligence.

The internet of behaviour could have significant effects on the more efficient use of humans in smart factories. For instance, by proactively addressing incorrect behaviours that employees may be prone to based on their psychological state (such as happy, sad, or anxious), measures can be taken to prevent work losses while gaining a significant advantage in terms of occupational health and safety. If products are produced while considering the behavioural analyses of customers, greater customer satisfaction can be achieved.

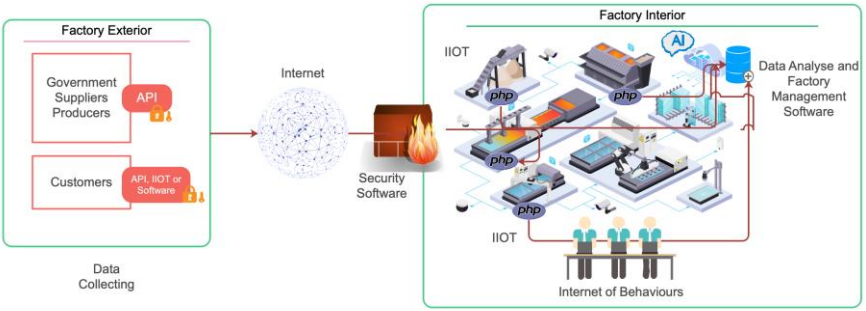

Figure-2: Data Collecting Infrustructure

2.2.Decision Support as a Result of Data Visualisation and Data Analysis

After collecting the necessary data using methods approved by factory management and data analysis software, the enterprise analyses existing data to gain valuable insights from the internal and external environment. Data classification during or after collection can facilitate the analysis process. Failure to establish proper structures for data classification can make it challenging to organise collected data later. To derive meaningful conclusions from collected data, the following methods for data visualization and analysis can be employed.

a.Data Visualisation

Smart factories gather increasing amounts of data from various digitalized and interconnected sources in various formats. One way of comprehending such vast and diverse data is through data visualization. In the present day, data visualization of AI-utilized information is generally categorized into three groups. (Zhou et al., 2019).

a) The first objective is to depict data in a compendious manner. This can be achieved through graphical representation, for instance, by depicting the quantity of goods manufactured in a smart factory, the percentage of defective products in

comparison to the overall production quantity, the outcomes of product marketing, and instantaneous production status.

b) b. The second objective comprises the integration of data using technologies like virtual reality (VR), augmented reality (AR), and mixed reality (MR). The second category, referred to as Immersive Technology in literature, utilises VR glasses, enabling individuals to work directly within a virtual environment without physical interaction. For instance, prior to production, employees may undergo training within a virtual environment, simulating real-life production scenarios. For instance, this virtual production environment is capable of imparting knowledge on ways to mitigate temperature elevation in a machine used for production. Through the employment of AR, immediate visualisation of the temperature of a real production setting becomes feasible. Consequently, the requisite measures to decrease temperature can be identified in the physical environment through AR. For instance, the button that regulates air flow to decrease temperature can be manually pressed on the machine. Alternatively, in MR, the button to lower temperature is engaged in the virtual realm, and not the physical one. In other words, the physical and virtual environments converge.

c) The third component relates to the design phase's schematics. Processes such as modelling using software like CAD/CAM, designing the product's structure and properties, and planning the production environment can be analysed in this category. The aim is to provide clear and objective information while ensuring a logical flow of ideas and using precise and formal language. It is also important to conform to conventional academic structures, including consistent citation and formatting features.

b.Data Analytics

The information gathered via the smart factory infrastructure is commonly known as big data in academic literature. This label refers to sizable and intricate datasets procured by companies and governments. These datasets are difficult to process through traditional data analysis techniques, as streams of data are amassed and stored at an unprecedented pace. The value of this information lies in the precious insights to gain from it (Grable & Lyons, 2018). This information is comparable to a valuable nugget amidst heaps of soil. This information is comparable to a valuable nugget amidst heaps of soil. The valuable nugget is discovered through extensive soil sifting, and its worth is priceless.

Big data has diverse applications across various sectors, including smart factory infrastructure, human resources management, finance, logistics, and public services. It proves particularly useful in sectors where monitoring production processes and customer behaviour is critical. For instance, in the healthcare sector, big data applications can aid in the early diagnosis of diseases. It is worth noting that using precise technical terms is essential to convey the meaning accurately (Gtech, 2020).

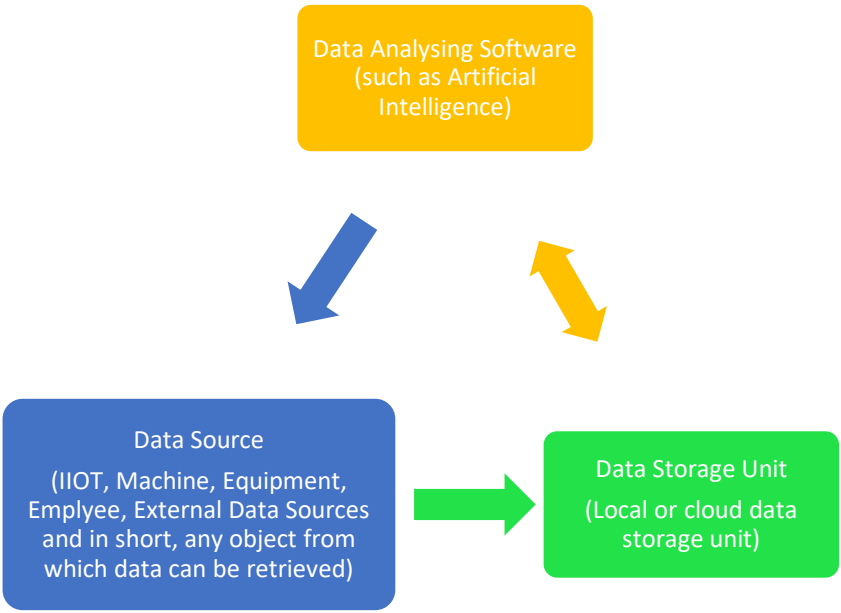

Figure 3: Analysis Process of Data Obtained from Data Sources

c.Artificial Intelligence

Artificial intelligence concerns the transfer of human-specific processes, such as reasoning, sense-making, generalisation, and learning from past experience, into the computer environment. (Copeland B.J., 2023). Artificial intelligence is a concept that has emerged from human intelligence, as the name suggests. Human intelligence plays a role in activities such as problem-solving, reasoning, experience gaining, and learning. In addition, humans possess a faculty called reason. Reason is a faculty that helps humans distinguish between right and wrong (Işık, 2020).

There are three distinct types of artificial intelligence: Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI). Artificial Narrow Intelligence is currently the most advanced form of artificial intelligence. In this category, machines can make decisions within

predefined parameters. All examples of artificial intelligence, including personal digital assistants and autonomous vehicles, belong to this category. In the field of artificial general intelligence, there are no predetermined limits to the development of artificial intelligence. It is capable of learning various tasks and performing them proficiently. This type of artificial intelligence is believed to develop itself in a way similar to how humans acquire knowledge through experience, ultimately reaching a level of intelligence close to that of humans. Artificial superintelligence refers to a state of artificial intelligence that surpasses human intelligence. (Bulutistan, 2022; Microsoft, 2023). The first type of artificial narrow intelligence (ANI) is the artificial intelligence used today. The other two types (AGI and ASI) are the targeted types.

Artificial intelligence comprises five distinct components. These are as follows: (Bulutistan, 2022);

a) **Machine Learning (ML):** This type of artificial intelligence is an application of artificial intelligence that uses data and algorithms to mimic the way humans learn, giving computer systems the ability to learn and improve from experience without explicit programming. An example is the spam filtering infrastructure in e-mail accounts(Bulutistan, 2022; IBM, 2023).

b) Deep Learning (DL): Deep learning is an intricate form of machine learning that implements artificial neural networks in its structure. To function effectively, Deep learning necessitates large datasets. Moreover, the system has a learning process that depends on feedback, where it is rewarded for each correct decision and penalised for each incorrect action.(Bulutistan, 2022; Microsoft, 2023)**.**

c) **Artificial neural networks (ANN):** Artificial neural networks mimic the analysis and processing of information by the human brain. Essentially, they imitate the nervous system in the human body. This system is composed of neurons that transmit neural impulses as electrical signals from the brain to

the body, from the body to the brain, and within the brain itself. In this artificial intelligence paradigm, sensors are analogous to neurons. (Bilim ve Teknik, n.d.; Bulutistan, 2022).

d) **Natural Language Processing (NLP):** Computers operate on a binary system of 0s and 1s, but human language is infinitely more complex. Natural language processing is an important component of artificial intelligence, enabling machines to read, comprehend, and generate human language. Examples of this technology include ubiquitous voice assistants. (Bulutistan, 2022)

e) Computer Vision (CV): Humans perceive objects visually and process them mentally. This mental process enables us to recognise a cat when we see one. Computer vision is a form of artificial intelligence that involves interpreting the contents of images or videos. The labelling of individuals in social media and photo gallery apps exemplifies this technology. (Bulutistan, 2022).

2.3.Process Management

Smart factories aim to establish the essential infrastructure for performing work in the most efficient manner possible. Automated workflows, process monitoring, and planning (such as pre-planning production processes through the digital twin method), maintenance (such as predicting faults in machinery and equipment before they occur), resource conservation (including time, energy, labour, and materials), and enhanced quality can increase productivity whilst reducing waste and costs.

In smart factories, data is collected from operational and processing activities, as well as from products that are either in production or have been sold to customers. This data is visualised, analysed, and transformed into new information which is then provided as input for both employees and autonomous systems. In turn, this leads to more accurate decision-making processes and

enables monitoring of smart factory components, including real-time warnings, notifications, and monitoring.

a.Cyber Physical Systems

Cyber-physical systems describe the communication integration between the physical and virtual worlds. Through the use of necessary objects such as sensors, computers, and smartphones, a connection between the two worlds is established. This connection allows for data from the physical world to be collected and analysed in the virtual world. The required axioms are then determined based on the results of these analyses. (Stankovic et al., 2017). Cyber-physical systems can be defined as the collaboration and integration of data obtained from operational systems, including machinery, equipment, and human resources, used in smart factories and information technologies employed in business processes such as finance, logistics, procurement, and accounting management. The coordination of these elements creates a digital ecosystem which also has the potential to introduce novel business models. (Apilioğulları, 2021) When the data in the resulting digital ecosystem is analysed, and then input to the equipment, machines, supplier systems and employees within the smart factory, operations in units such as production, finance, and human resources may increase efficiency, minimize capacity loss, and lead to more customised production.

b.Digital Twin

Digital twin technology is the modelling of an object in the physical world in the virtual world. It covers the life cycle of the object and uses real-time data sent from sensors on the object to simulate its behaviour and monitor operations. Digital twins can be created from a single piece of equipment in a factory to a virtual twin of many physical objects and processes, such as an entire manufacturing process. This technology enables the performance of an object to be monitored, potential failures to be identified and intervened before they occur, more informed decisions to be made

about the product life cycle (Amazon Web Services, 2022), and waste to be prevented by planning in advance in production processes. This technology is crucial for the establishment of cyber physical systems. For example, if the digital twin of the production process can be modelled in the virtual world, the production process can become integrated with supply chain and logistics systems (Balderas et al., 2021).A study conducted by the Capgemini Institute on 1000 enterprises in 2022 on digital twin technology shows that 52% of enterprises using digital twin technology can use digital twin technology in a wide range of areas, including the manufacture of consumer products and 34% in energy consumption and carbon emission calculation. In the same study, it is thought that the adoption of digital twin technology use may increase by 36% within 5 years. Among the reasons for this increase, 79% of the enterprises participating in the research were shown to aim for cost savings, 77% for technological progress and 57% for sustainability (Gapgemini, 2022).

2.4.Cyber Security

When assessing the cybersecurity procedures of smart factories, it is imperative to conduct thorough research that takes into account a comprehensive cybersecurity approach encompassing both information technology and operational technology while considering employee-related processes. It is essential to note that cybersecurity methods used in information technology should not be mistaken for those used in operational technology. To maintain comprehensive safeguards, cyber security awareness trainings and updated employee practices must be sustained. Holistically, the text must adhere to conventional format, remain balanced in its presentation, and avoid informal language or jargon.

Operational technology's software data is transmitted to data storage systems and subsequently to analytical software via information technology's infrastructure (CISA, 2023). It is imperative that technical abbreviations are explained during their initial use, and objective evaluations are expressed with clarity and

precision. The security of software running in the machinery and equipment used in operational technologies presents challenges in closing vulnerabilities that may arise when the warranty and software update support for such machinery and equipment comes to an end. Therefore, when designing AI connections for this type of machinery and equipment, it is crucial to isolate them from the network of other machinery and equipment. Ensuring that all software used in both operational technologies and information technologies is constantly kept up to date, updating the operating system infrastructures upon which the software operates (CISA, 2023), defining the resources to which software is granted access via firewalls, and determining which resources employees can access through central authentication and authorisation mechanisms are key measures that can be implemented within the field of cyber security. Storing sensitive information like login details for staff and the whole system on a central identity management software and accessing the necessary credentials for other systems through this software can offer convenience and enhance cybersecurity.

a. Some Software that can be used for Cyber Security

Some open source software developed by Tübitak related to Cyber Security are described below.

b.Engerek Identity Management Software

Engerek, an open source identity management solution, runs on the Linux-based Pardus operating system, developed by Tübitak in Türkiye.Engerek is open source

The official website of Pardus includes the following explanations about Engerek (Pardus, n.d.-b).

Engerek is a web-based identity management system. It was developed with the Java programming language. Its main goal is to centrally manage corporate users and accounts. It has been developed as open source. It runs on Tomcat application server and

supports MariaDB / MySQL / PostgreSQL databases as identity store.

c.Ahtapot Cyber Security Software

The cyber security solution Ahtapot, which runs on the Linux-based Pardus operating system developed by Tübitak in Türkiye, is open source.

The official website of Pardus includes the following explanations about Ahtapot (Pardus, n.d.-a):

What is an Ahtapot?

One of the important rules that must be followed in order for cyber security measures to be successful is to include all cyber security components that must be included in the information system.

"Defense-in-depth" or "multi-level defense" is the coordinated use of multiple security measures to ensure information security in an institution/company. Defense in depth minimizes the likelihood of attackers succeeding. When the attacker bypasses a security measure on his way to achieve his goal, he will encounter another, which will at least make the attacker's job more difficult and increase the time it takes to reach his goal.

How does it work?

It is a system in which the cyber security components needed for defense in depth are integrated. Ahtapot has the following features;

Operating System is Pardus; In this way, open source national operating system distribution is used in cyber security components.

It consists of open source components; In this way, systems that we cannot control and that we cannot know with whom they share which information are avoided.

Ahtapot; It includes a central management system to facilitate installations, configurations and updates.

It has easy-to-understand installation and user manuals.

3.General Evaluation

Smart factories are structures that use the data and information obtained from the internal and external environment of the factory to manage the processes of the factory. Different types of software can be used in the management of smart factories. Care should be taken to ensure that the software to be used can communicate with each other without any problems and that the data produced by the software can be recognised and analysed by the factory management software.

It is very important whether the systems on which the smart factory software will work are with the local resources of the factory or with cloud-based resources. Because the cost calculation here should be taken into consideration that the cost calculation will vary according to the resources needed by each enterprise or factory.

While establishing the smart factory software infrastructure, cyber security issues should be taken into consideration. In this context, a holistic cyber security infrastructure that includes operational technologies, information technologies and employees should be designed. While designing this infrastructure, open source or closed source software can be preferred according to the request of the employees responsible for operational technology and information technologies of the factory.

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CHAPTER II

Introduction to Machine Learning

Ayşe SALMAN

1.What is Machine Learning?

Machine learning (ML) is a field that studies the ability of a machine to learn from input data, and gradually improves its output accuracy. This means it can behave in a manner of intelligence that develops through learning likes humans do.

The conventional way to make a computer accomplish certain task is by writing explicit instructions in some programming language to execute number of steps required to solve the problem at hand. This proved to be highly successful and many software have been developed and already running to accomplish tasks in applications in numerous fields. However, this method is not always practical or even feasible in many other applications. For example, in applications such as image recognition (training a computer to recognize pictures of different people), handwriting recognition or voice recognition, traditional programming methods is not feasible. This is due to the immense number of different possibilities and combinations in the input data to be considered. It would be easier,

instead of explicit instructions, to use a program that learns from the input data. This means taking the approach of letting computers learn to program themselves through experience gained from the input data or what we call *machine learning*.

Work in the field of machine learning has been motivated right from its inception by trying to mimic human intelligence through learning by writing algorithms that can learn from observation or input data. In the learning process, algorithms are constructed that can build a model from input dataset. The data set is used for the training and testing the model. The training and testing are carried on over and over again until the model is considered satisfactory. The model can then be used to make predictions or decisions expressed as outputs and without being explicitly programmed to do so.

Historically The term "Machine Learning" first appeared in 1959 by Arthur Samuel[1] who developed a computer program that learns to play Checkers game. He coined the term "Machine Learning" as "Field of study that gives computers the ability to learn without being explicitly programmed.'' This work is considered a milestone in the field of artificial intelligence and his definition became the most cited definition of ML.

However, Tom M. Mitchell[2] (1998) provided a more formal definition of ML as *well-posed* learning problem: ''A machine learns with respect to a particular task T, performance metric P, and type of experience E, if the system reliably improves its performance P at task T, following experience E'' and for each learning process we specify T, P, and E. For example, E could be a collected dataset of

[1] Samuel, Arthur (1959). "Some Studies in Machine Learning Using the Game of Checkers". *IBM Journal of Research and Development*. **3** (3): 210–229.

[2] Tom M. Mitchell (1998). ''The Discipline of Machine Learning''. School of Computer Science, Carnegie Mellon University, Pittsburgh, PA, USA, CMU-ML-06-108.

images, task T could be image recognition, and performance P could be the proportion of correctly categorized images.

Currently machine learning is considered a subfield or branch of the field of Artificial Intelligence (AI). It has become the most important part of AI and most current advances in AI have involved machine learning.

The discipline of ML is closely related to number of other fields particularly Statistics and Data Science. The ideas of machine learning, from methodological principles to theoretical tools, have been for long established part of statistics. Statistics provides an important set of tools used at each step of a machine learning project.

ML is also considered an essential tool in the growing field of Data Science. In this field typically large amount of data are analysed to extract or extrapolate knowledge from it whatever the type of data structured, or unstructured. ML is used as a data analysis tool to examine and interpret such data and to uncover key insights in it to solve problems in a wide range of application domains.

Applications: ML is used in many and diverse applications and this is growing to cover pretty much every imaginable application. From medical diagnosis to creative art to ML projects applied to industry and almost all engineering fields. ML is also applied to literature understanding, to finance and business, to banking, and actually to many more fields. In general, the applications of machine learning are widespread as it is fast becoming an integral part of many different fields.

2.Machine Learning Paradigms

The discipline of machine learning employs various approaches to teach computers to accomplish tasks. These learning approaches are traditionally divided into three broad categories, which correspond to real learning paradigms. These are: *supervised learning* (SL), *unsupervised learning* and *reinforcement learning*

(RL). In addition, there are other several approaches most of which are variations or hybrids of the basic paradigms.

a.Supervised Learning (SL)

In this method the machine learning model is trained with the *training dataset* explicitly *labelled* by human experts. Each training example is a *pair* (X,Y) consisting of an input of X features (typically a vector called *feature vector*) and a desired output values Y (the *labels*) and the training data is represented by a matrix. Through training, the algorithm analyses the training data and infers a function, which can be used for mapping new unlabelled examples including samples that have not seen previously by the algorithm. so that given a new X it can map it to the most appropriate output Y (the class labels).

After training, the model is evaluated and tested by feeding it the *test dataset*. Model parameters may be adjusted for optimizing the model's performance. The result is a model that can be used in the future to predict the output given new sets of input data.

Supervised Learning is the most and widely used style of learning. Today most production machine learning applications are based on supervised learning as it helps organizations solve a variety of real-world problems. The two most common supervised machine learning tasks are *classification* and *regression.*

- Classification is a learning task for which the goal is to assign input data into specific categories. i.e., it recognizes the class or type of an entity within a dataset according to a number of options. Classification is the basis of many applications, such as detecting if an email is spam or not, identifying images, or diagnosing diseases. The common classification algorithms are *linear classifiers, support vector machines (SVM), decision trees, k-nearest neighbour*, and *random forest.*
- Regression is a learning task for which the goal is to understand the relationship between dependent and

independent variables. Many problems can be identified as a regression problem such as predicting prices, or population sizes. It is commonly used to make projections, such as in sales revenue for a given business. The common classification algorithms are *Linear regression, logistical regression*, and *polynomial regression*.

b.Unsupervised Learning

Here, the model is trained with unlabelled data, i.e., the training data do not contain any tag information (i.e., no means of supervising, hence learning is ‘’unsupervised’’). The input is thus a training dataset of X features but with no Y labels. The task of the learning model is analysing the input dataset to find interesting structure and hidden patterns independently without human intervention and make predictions accordingly.

The main tasks of unsupervised learning models are *clustering*, *association* and *dimensionality reduction*.

- Clustering goal is to separate a set of examples into groups based on their similarities or differences. Clustering has many applications, such as customers segmentation (to design better products, ads, etc.), and news aggregation.
- Association method uses different rules to find relationships between variables in a given dataset. These methods are frequently used for market basket analysis to understand consumption habits of customers and make recommendations.
- Dimensionality Reduction is a learning technique used when the number of features (or dimensions) in a given dataset is too high. It reduces the number of variables in input dataset to a manageable size while also preserving the data integrity. Dimensionality reduction can be used in data preparation phase for just about any machine learning application, but it can also be used by itself for specific applications such as

reducing noise in an image in visual data to improve picture quality.

Unsupervised learning is less used than SL mostly because its results can be inaccurate and require more human intervention for validation. However, it is mostly useful in certain types of applications. Its ability to discover similarities and differences in information makes it the ideal solution for tasks such as exploratory data analysis, cross-selling strategies, and customer segmentation.

c.Reinforcement Learning (RL)

In this learning paradigm the aim is to train an AI-based system (referred to as an *autonomous intelligent agent*) to perform its task better through a trial-and-error strategy. The learning is guided by cumulative rewards given to the *agent* depending on its action with the aim to maximise its performance. More precisely, the agent learns mapping or strategy (called *policy*) that maximizes this reward.

An *autonomous intelligent agent* (or just *agent*) is a piece of software that acts for a user or for another program to achieve a specific goal or set of goals. The agent perceives its environment, takes actions autonomously and continuously, and it improves its performance with learning.

Reinforcement learning is fundamentally different from supervised and unsupervised learning styles in the way data is provided for training the agent. Here that the data is not provided as a static tabular dataset, rather, the data is obtained through the model interacting with its *environment*. The data input will be in the form of sequence of data points in the form of *environment state* and *actions* which lead to a *reward*. The objective of learning is to produce a *policy* i.e., a mapping or strategy that suggests the actions that the agent should take for every possible state of the environment. The input in RL is thus a sequence of tuples in the form of "*State-Action-Reward-State-Action*".

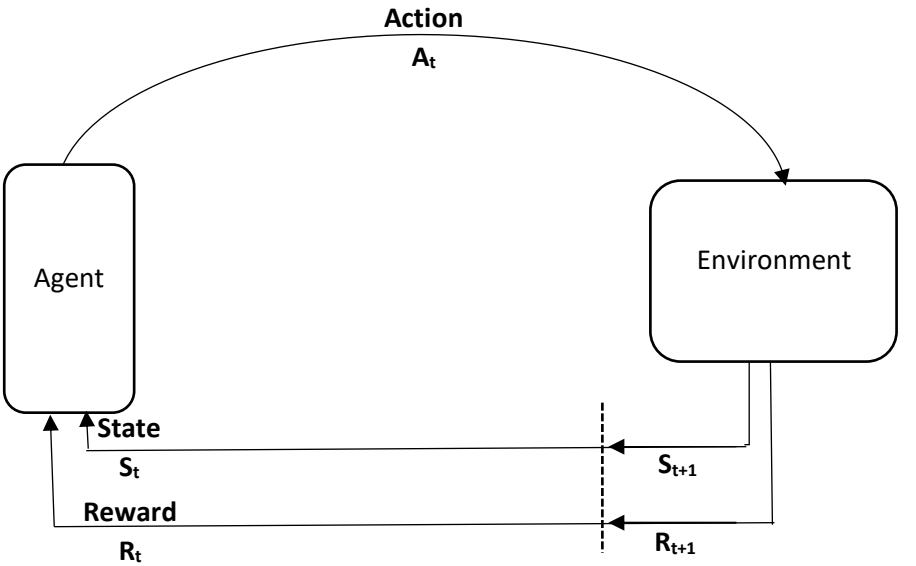

Fig. 1. Representation of The Transitions in Reinforcement Learning.

Reinforcement learning is often used to teach agents, such as robots, to learn a given task. For example, it can be used by a robot to learn how to walk in a simulated environment. It has also been used to teach computers to play games. The goal here is to maximize the points won in a game over many moves. For example, *AlphaGo*, that plays the Chinese board game *Go*. It is also used in the field of control engineering. The goal here is to dynamically control the behaviour of a system (an engine, a building, etc.) for it to behave optimally. Other uses are to train *autonomous vehicles* driving, to improve crop production, to trade stocks and also in software application *chatbot* that learns by having online conversation with human user in natural language.

Reinforcement learning closely mimics human learning pattern since the agent is learning by interacting with environment; observing, and gradually learns through trial-and-error action, like humans do.

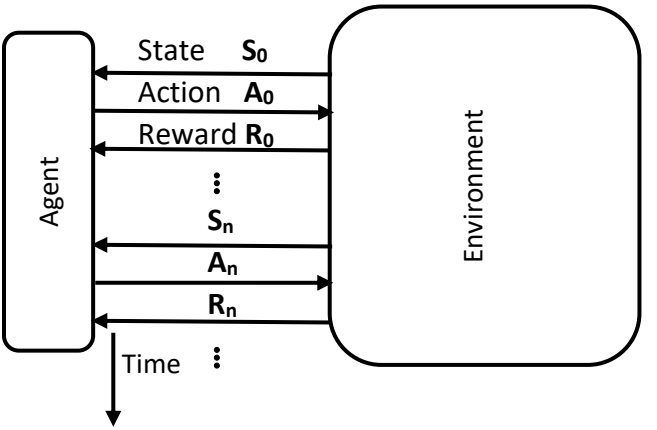

Fig. 2. Reinforcement learning model.

3.Other Learning Methods

Supervised, unsupervised, and reinforcement learning are the three core learning paradigms. Nevertheless, there are other ways to learn that are based on these core paradigms in some combination or with some variation that may depend on the specificities of the problem to solve or the type of the input data. In general, different learning methods typically solve different kinds of tasks. Here are the main other learning paradigms.

a.Semi-Supervised Learning

This is a branch of machine learning that lies between supervised and unsupervised learning methods. In the supervised paradigm all the input data is labelled, whereas in the unsupervised paradigm all the data is unlabelled. In semi-supervised learning the model is trained from a dataset that includes both types of data; labelled and unlabelled. Typically, the unlabelled dataset is much bigger than the labelled dataset and the goal is to learn a predictive model from such combination datasets.

The main objective of semi-supervised learning is to overcome the shortcomings of both supervised and unsupervised

learning. Supervised learning requires huge amount of labelled data for training, which is often expensive and time-consuming process. There may be large amount of unlabelled data available but there is no means to get enough labelled data to produce an accurate supervised model. In fact, in many of the real-world applications (e.g., image processing and text processing), there is an abundant supply of unlabelled data, but requires human experts to label them. On the other hand, unsupervised learning clusters unlabelled data based on similarity in the data points by using either clustering or maximum likelihood, an approach that suffers poor accuracy. Semi-supervised learning can be the technique used to increase the size of the training data. The idea behind it is that labelling just a small sample of large data might be enough to result in the similar accuracy or even better than fully labelled training data.

There are several approaches to semi-supervised learning, most common are *self-training* and *co-training*.

Self-training: in this approach the model is trained at the beginning on only the labelled data. The resulting model is used to obtain predictions for the unlabelled data points. Then, the most confident of these predictions are added to the labelled data set, and the model is re-trained on both the original labelled data and the newly obtained labelled data (called *pseudo-labelled* data). This procedure is typically iterated until no more unlabelled data remain.

Co-training: in this approach the model is trained based on two *views* of data i.e., to treat a datapoint differently based on whether it has a label or not. After each training step, the most confident predictions for each view are added to the set of labelled data for the other view. Then, the retrained model is fed with the new data, more accurately predicting using supervised machine learning techniques.

Semi-supervised learning is of great use in a variety of applications for which vast quantities of unlabelled data are available for training while labelling small amount can lead to a significant improvement in accuracy. For example, natural language processing

(NLP), large volume of datasets like network traffic classification and speech recognition. It is effective for medical images categorization, for which only small amount of training data could be labelled by experts. Used as well in person identification in Web-cam images where here also a few training images are labeled.

b.Active Learning (AL)

This is a ML method in which the model requests the information it needs to perform better. This method ensures that a model is trained only on the data most likely to increase its performance. At the beginning of an active learning procedure, the input consists of only unlabelled data i.e., of input but no output. During the learning procedure, the model can request some of the unknown outputs from an *oracle* (most of the time, is a human annotator, but it could also be a program) to predict the output from a given input. This iterative ‘’human-in-the-loop’’ method is built on the idea that not all samples are valuable for learning, so the algorithm chooses the data it learns from.

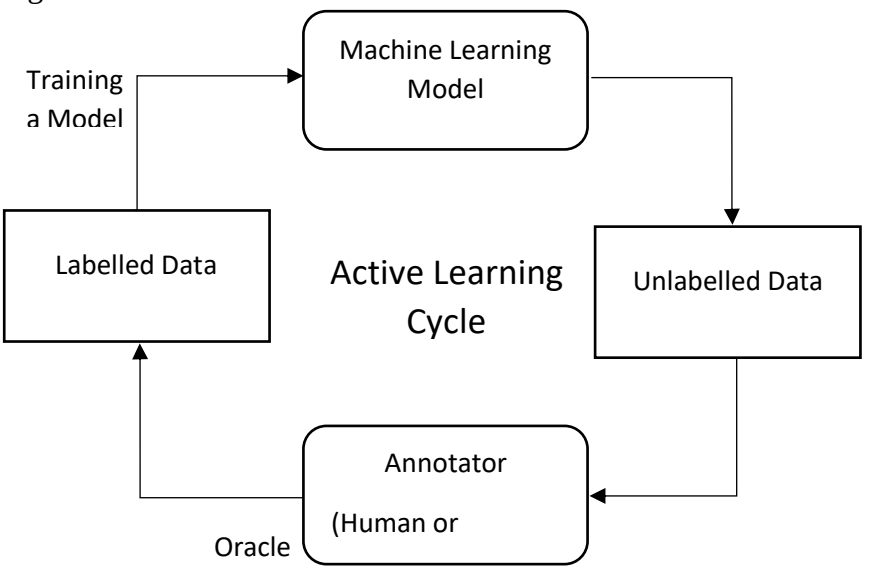

Fig. 3. Active learning loop.

AL can be considered a type of semi-supervised learning, meaning models are trained using both partly labelled and mainly unlabelled data. However, here labelling data is done dynamically and incrementally during the training phase. The basic concept behind active learning is that a learning algorithm can potentially achieve greater accuracy with fewer training labels if it is allowed to choose what label would be the most beneficial for it to learn from. Active learning can also be seen as a subset of reinforcement learning since the model can be considered an active agent but with the difference that the agent here cannot alter the environment.

AL is very popular in the areas of natural language processing (NLP), computer vision and recommendation systems. Many such applications require lots of labelled data which has high prohibitive cost to labelling and active learning is key to address such problem while improving performance.

c.Transfer Learning

This is a learning approach that deals with transferring knowledge gained from one learning task to another learning task. This is particularly useful when the second task is related to the first task or when there is limited data available for the second task. The strategy is generally to train a model on the large dataset and then use this *pre-trained model* to help train another model, perhaps on limited data, on the task that is the real target.

Transferring information from previously learned tasks to new tasks has the potential to significantly improve learning efficiency and as a result, great amounts of time and resources can be saved. However, transfer of knowledge is only possible if the *source* task is sufficiently related to the *target* task. The pre-trained model may not be well-suited to the second task if the two tasks are vastly different or the data distribution between the two tasks is very different.

Transfer learning can be used to build better models. By using the learned features from the first task as a starting point, the

model can learn more quickly and effectively on the second task. This can also help to prevent *overfitting*, as the model will have already learned general features that are likely to be useful in the second task.

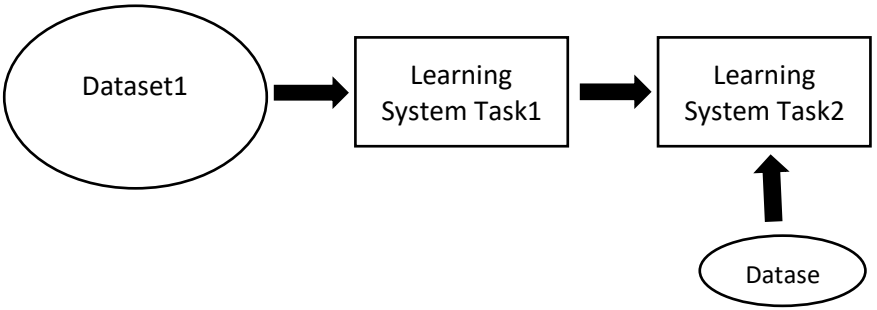

Fig. 4. Transfer Learning Model.

Transfer learning is very popular in domains like NLP and computer vision used to learn from image, audio, and text data. For example, machine learning models trained on images learn similar features (edges, corners, gradients, simple shapes, etc.) from different image datasets, these features can then be reused to solve other image recognition tasks. Without transfer learning, it would be hard to accomplish something useful in these domains.

d.Self-Supervised Learning (SSL)

This is a machine learning approach where the model trains itself to learn the data representation. Once the model learned how to represent data, it can then be used to tackle a *downstream task* (the actual problem to solve).

SSL employs two main phases: *pretext task* and *downstream tasks*. In pretext task stage pseudo labels are generated automatically without human intervention by taking into account the attributes of the dataset. These pseudo labels are then used in the downstream tasks stage through a *knowledge transfer* procedure.

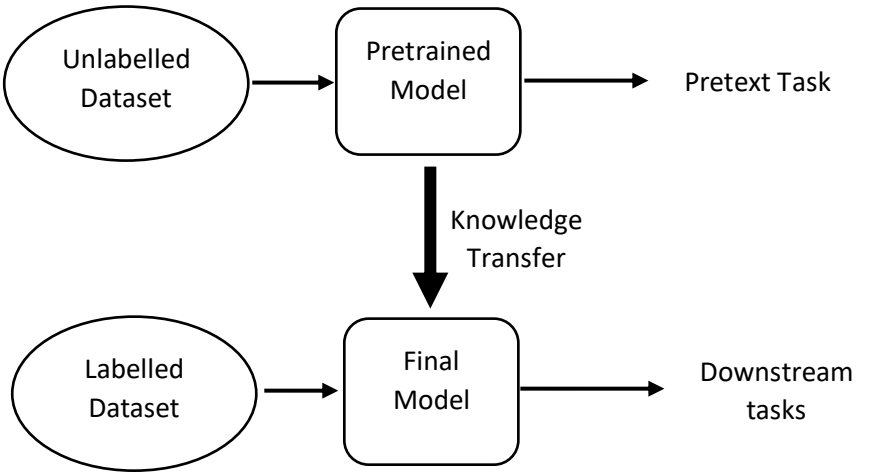

Fig. 5. Self-supervised Learning Model.

The main advantage of SSL methods is that they do not need human-annotated labels, which means they are designed to take in datasets consisting entirely of unlabelled data samples. The draw backs of SSL are its demand for more computing power, and it can suffer from poor accuracy.

Self-supervised learning is mostly used in computer vision for tasks like colorization, 3D rotation, depth completion, or context filling (fill a space in an image or predict a gap in a voice recording) or in helping to predict the missing words within a text. Mostly, its applications focus on *improving* computer vision and improving natural language processing (NLP) capabilities.

e.Online Learning (OL)

This is a technique of machine learning in which the model learns iteratively from a data that arrives in sequential order, and the model updates itself after each step of input.

This technique is in contrast to the traditional machine learning methods that run in *offline* (*batch*) mode. Batch mode generates the best predictor by learning on the entire training dataset

that is fed in advance. However, it suffer from drawbacks like low efficiency in both run time and memory space. Also, it suffers from poor scalability for large-scale applications because the model often has to retrain from scratch for any new batch of data.

Online learning is able to overcome the drawbacks of offline learning, meaning learning takes place as data becomes available and the model can be updated instantly for any change in data after learning from each individual training instance. Therefore, online learning is far more efficient in time and space and scalable for large-scale learning tasks in real-world data, where data is not only large in size but is also provided as stream over time. Online learning is also useful because it naturally gives more importance to more recent data than to older data (which is often less relevant).

OL is not really a paradigm in itself since the underlying problem can be both supervised (labelled examples) or unsupervised (unlabelled examples).

OL is a common technique used in areas of machine learning where it is computationally infeasible to train over the entire dataset. It is also used in situations where it is necessary for the algorithm to dynamically adapt to new patterns in the data, or when the data itself is generated as a function of time. For example, it is particularly useful in applications that predicts the weather or in stock price prediction. It is commonly used in the finance market and economics, where new data is always emerging. In particular in regression analysis tasks, i.e., time series analysis in financial markets, where data instances naturally arrive in sequential order.

4.Deep Learning

Deep learning (DL) is a class of machine learning algorithms that is based on using *artificial neural network* (ANN) with multiple layers between the input and output layers (called deep neural network). Learning in deep learning can be in any of the traditional styles such as supervised or unsupervised.

Artificial neural networks are at the heart of deep learning algorithms. They are comprised of node layers, containing an input layer, one or more *hidden* layers, and an output layer. Each node (an *artificial neuron*) connects to another and has an associated *weight* and *threshold*. A node is activated sending data to the next layer if its output is above the threshold value. The weight represents the strength of the connection, larger weight value will more significantly change the output. These components as a whole function similarly to a human brain and can be trained like any other ML algorithm allowing it to "learn" from large amounts of data. There are various types of ANNs, which are used for different use cases and data types. In general, a neural network that consists of more than three layers which would be inclusive of the input and output layers (i.e., deep neural network) can be considered a deep learning algorithm.

In deep learning (as in many machine learnings) useful representations makes an effective learning task. The hidden layers of the neural network can be performing *representation learning* as a pre-processing step before performing classification or predictions. **Representation learning** (or **feature learning**) is an approach in machine learning for feature extraction from unlabelled data by training a neural network on learning representations of data that are useful for a specific task. The input layer in combination with all hidden layers is supposed to convert the input to useful representation. Each hidden layer maps its input data to an *inner representation* that tends to capture a higher level of abstraction. The performance of deep machine learning algorithm largely depends on the representations it receives. This representation acts as input to the last layer which usually is a classification layer. This classifier makes use of the representation received from earlier layers towards the machine learning task that was intended to perform.

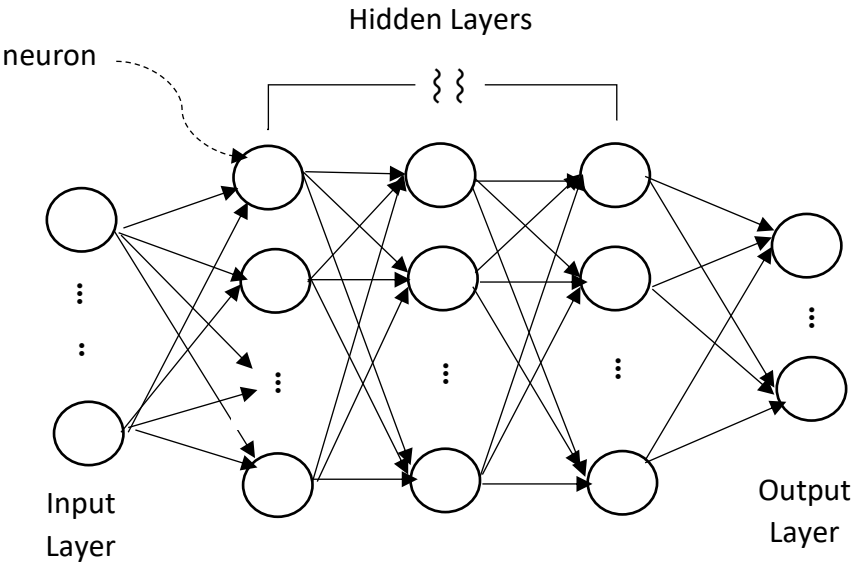

Fig. 6. Deep Neural Network Model.

However, deep learning algorithms are incredibly complex and require a tremendous amount of computing power than any other traditional learning algorithm. But due to the acquisition of large amount of data and the massive computational power available today, deep learning methods are now heavily used and different types of neural networks are now available to address specific problems or datasets.

The deep learning technology is now applied in various fields and used for many different tasks and applications. Few examples are self-driving cars, chatbots, automatic speech recognition (ASR), computer vision, image recognition and medical image analysis. Also in financial services, forecasting and marketing research, fraud detection and risk assessment. They also provide the best solutions in problems like image recognition, speech recognition, and natural language processing.

5.Machine Learning Process

There are six main phases in the machine learning process:

1.Data Acquisition.

Machine learning starts with data, acquiring the data is the basic and first step of the machine learning process. The data may come from different sources, it can be real-life data gathered and stored before, or comes as online stream of data, it may come from synthetic data generators, or it is a reference dataset publicly accessible.

2.Data preparation.

This is the act of manipulating the raw data into a form that can be used to train and evaluate a machine learning model. Data preparation is a complex task, it can include several activities and it is time-consuming as well. Generally, there is a number of common or standard activities in data preparation. These main activities are as follows:

- Data fusion and Data augmentation: First integrating data if data comes from multiple sources and in different formats. This is to produce more consistent and useful data.
- Also, augmentation techniques may sometimes be needed to increase the amount of data and helps to reduce *overfitting*. Overfitting is a common problem in machine learning, and it happens when the model starts learning from the noise and inaccuracies in the data entries. Overfitting reduces the model's ability to generalize and fit to additional data or predict future observations reliably.
- Data Cleaning: This is the process of detecting and correcting or removing mistakes or errors in the data. Also identifying and removing duplicates, irrelevant parts and extraneous information in the data.

- Feature Selection: Feature (also known as variable or attribute) is an individual measurable property or characteristic of a phenomenon. The data may contain some features that are either *redundant* or *irrelevant* and can thus be removed without much loss of information. Feature selection identifies and selects those input variables that are most relevant to the task for use in model construction.

- Dimensionality Reduction: The number of input variables or features in a training dataset is called its dimensionality. Large number of input features (variables) in dataset can cause poor performance for ML algorithms. Dimensionality reduction is the process of reducing the number of input features. A model with too many dimensions (also called parameters) is likely to *overfit* the training dataset and therefore may not perform well on new data.

- Data labelling: This is the process of adding tags or labels to the data used for training in *supervised learning* paradigm. These tags form a representation of what class of objects the data belongs to and helps a machine learning model learn to identify that particular class of objects when encountered in data without a tag. Data labelling is mainly a time-consuming and labour-intensive process.

- Data Splitting: One major component of data preparation phase is breaking down the datasets into multiple sets . In particular, three or two data sets are commonly used in different stages of the creation of the model: training, validation, and testing. A larger part (~80%) would be used for training (or training and validating) the model, as better training requires more data. While the other smaller part (~20%) is used for testing and evaluation purposes. Data splitting is an essential aspect of data preparation for an unbiased evaluation of models' performance.

3.Choosing a Model

Model selection is the process of selecting the machine learning model that is most appropriate for a given task. There is a variety of model selection approaches, and the following are a number of determining factors to be considered in model selection:

- Type of the Problem: Machine learning algorithms were designed that each solves a specific problem and serves a specific purpose like *classification, regression* etc. So, understanding the problem and what kind of an output is required is basic factor in selecting a model.
- Accuracy: Accuracy in machine learning measures the effectiveness of a model prediction; how accurate its outcome in generalizing to new data it has not seen before. Sometimes an approximation is adequate which reduces the model's processing time effort. Approximate methods also naturally tend to avoid *overfitting*.
- Training Time: Time taken to train a model varies between algorithms. However, the running time is a factor of the size of the data set and the accuracy required. Higher quality output means longer time training. But if only approximate output is adequate fast training might be enough.
- Linearity: Using a linear machine learning algorithm such as *linear regression* is simpler and takes less time to train. So, linear approach to the problem solution should be followed whenever possible. However, linear algorithms assume linear data which might not be the case for more complex problems and might lower the accuracy. Despite this drawbacks, linear algorithms can still be used as a first strategy to serve as a benchmark to try more complex algorithms.
- Number of Parameters: Parameters, such as error tolerance or the number of iterations, are factors that affect the algorithm's behaviour. An algorithm with large numbers of parameters typically indicates that it has greater flexibility. It can often

achieve very good accuracy but increases much the time required to train.

- Number of Features: For certain types of data, the number of features can be very large compared to the number of data points. However, large number of features can complicate learning algorithms, making training time unfeasibly long. The algorithm preferred should be from those particularly suited to dealing with a high number of features.

1.Model Training

The training process is a long series of trial and error. The training dataset is fed to the algorithm, and over time the human programmer can observe how the model interprets the data. If necessary, adjustments are made including changing the model parameters to make it more accurate. As the process continues, the model should get increasingly reliable.

2.Model Testing and Evaluation

After training, the model needs to be tested to check its accuracy. This is done by feeding the model with the new unseen dataset part allocated for testing (from Step 3). If the results are not satisfactory, the prior steps need to be revisited so the root cause behind the model's underperformance can be identified and, subsequently, rectified. The model should be further retrained and re-evaluated over and over again until reaching acceptable level. Once satisfactory, deployment follows.

3.Deployment

This is the process of placing the finished machine learning model into a production environment where it can be used for its intended purpose. However, deploying a model is not a one-time exercise but rather a continuous process. This is because for a model to predict accurately, the data that it is making predictions on must have a similar distribution as the data on which the model was trained. In actual environment that might not always be the case and

data distributions can be expected to change or drift over time. The usual practice is to continuously monitor the incoming data and retrain the model on newer data if the data distribution has deviated significantly from the original training data distribution.

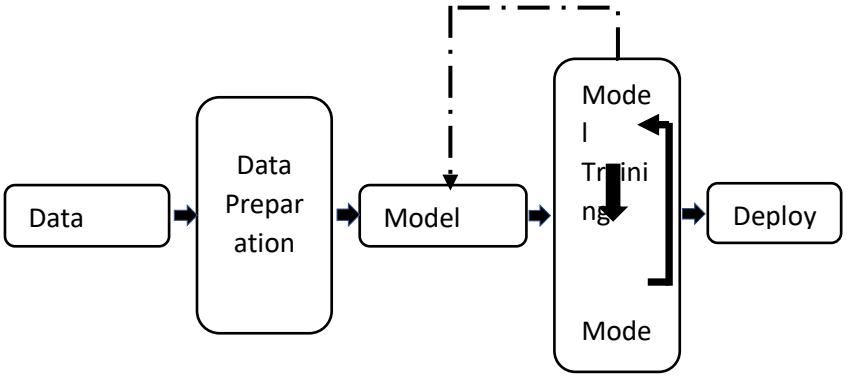

Fig. 7. A Pictorial Representation of the Learning Process.

CHAPTER III

The Next Step in Business: Digital Employees Experience

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What is the digital employee experience?

The concept of digital employee experience has only recently risen to the foreground of workplace technology argumentation (Daud et al., 2021). Although some may think that this is a new topic, the truth is that professionals have been talking about the significance of the knowledge of the digital worker for a few years (Gheidar and Zanjani, 2020). In fact, the significance of this area of argument was first attentioned by the writer and futurist

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Jacob Morgan. In his book Morgan first debated the digital employee experience and how it will figure the future of work (Syahchari et al., 2021).

Employee experience refers to the sum of all interplays employees have with their employer, including its culture, job duties and work environment. This is an significant part of creating a productive workplace because it can effect employee retention, engagement and productivity (Chandwani, Shah, & Shaikh, 2021).

The notion behind DEX is that employees have the best possible experiences and digital tools for their jobs. From software to virtual communication channels and mobile applications, the focus is on obtainment employees with digital solutions that make their more efficient and easier (Joshi, Sekar, & Das, 2023). Digital employee experience refers the effect of digital technologies on interaction with the work environment and the employee. This includes optimizing digital platforms and tools to improve employee satisfaction, engagement and productivity (Gheidar and Zanjani, 2021).

A positive digital employee experience is necessary in today's extremely competitive job market, where organizations are frequently looking for ways to retain and attract top talent. This includes creating a seamless digital experience that provides easy access to information, personalized content and powerful technology tools (Meret et al., 2018). By focusing on optimizing employees' digital experience, organizations can increase employee productivity, reduce turnover, and ultimately promote business success (Joshi, Sekar, & Das, 2023).

Differences between employee experience and digital employee experience

As organizations move towards digital transformation, investment in employee experience has also increased. Employee experience refers to the general feeling and journey of the employee during his tenure (Gheidar and Zanjani, 2020). But as the work

culture evolves, the digital employee experience has become an important aspect. Unlike employee experience, digital employee experience refers to communication and the use of digital tools to increase productivity, collaboration and engagement. The critical difference between the two is the medium (Joshi, Sekar, & Das, 2023). Employee experience focuses on human relationships, while digital employee experience centers on using digital tools to create the optimal workplace. Understanding the distinction between the two is very important to creating a modern workplace that appropriate the needs of the workforce (Moganadas and Goh, 2022).

Research in recent years on the digital employee experience have shown that confront to the traditional employee experience, the digital experience is allows and more effective companies to get the most out of their workforce (Selimović, Pilav-Velić and Krndžija, 2021). According to Raia (2017) indicated that with the help of digital experiences, organizations can create a more collaborative, engaging and productive workplace.

The workplace is frequently evolving and modern employers are now focalizing on the digital employee experience rather than the traditional employee experience (Shahi and Sinha, 2020). Digital employee experience means to the use of digital tools such as internal communication systems, video conferencing, online platforms and programs, to create an optimum work environment for employees (Gheidar and Zanjani, 2021). This differences from the traditional employee experience, which focuses more on interpersonal relationships between management and coworkers. Understanding the distinction between these two concepts is necessary in creating a accomplished work culture that create to the needs of today's workforce (Schneider & Kokshagina, 2021).

Digital employee experiences involve using technology-based solutions for improving communication among teams and departments within an organization (Ludike, 2018). For example, many organizations are implementing chatbot services that can provide quick answers to common questions related to HR policies

or payroll matters without having an actual person answer them every time (Selimović, Pilav-Velić & Krndžija, 2021). Additionally, companies have also adopted virtual reality (VR) technologies for training purposes since it offers a hands-on approach with real-life simulations at minimal costs compared with other conventional methods like classroom lectures or seminars (Chandwani, Shah, & Shaikh, 2021). Furthermore, AI-driven analytics can be used by managers to gain insights into their team's performance and identify areas where improvement is needed while providing personalized feedback based on individual goals set by each team member (Zel & Kongar, 2020).

Why is Digital Employees Experience is so Important?

Employees are now working remotely on different devices and in various locations, making digital touchpoints vital for communication and collaboration (Cetindamar & Abedin, 2021). DEX can offer employees a smooth and engaging digital environment while carrying out their tasks. Providing a positive employee experience can increase engagement and productivity and reduce employee turnover (Zel and Kogar, 2020). Digital employee experience is not about proposal new technologies, but about creating working circumstances that put employees value and first their additives (Selimović, Pilav-Velić, & Krndžija, 2021). By giving employees accession to the tools, support and information they need in the digital workplace. Organizations can optimize their workforce, achieve their goals and drive innovation. Digital employee experience (DEX) is a concept that has been acquisition attention in last years (Syahchari et al., 2021). We focus on providing employees with a meaningful and simple digital experience so they can work productively from anywhere. By optimizing the employee experience, organizations can develop engagement and efficiently and reduce labor costs (Joshi, Sekar, & Das, 2023).

DEX's main mission is to put employees first. Companies should endeavor to create an environment where all members value their additives and have access to the tools needed to succeed (Meske

& Junglas, 2021). This includes giving employees autonomy, offering reliable support services and providing clear communication channels in their work flow (Moganadas and Goh, 2022). Organizations also need to make importance and new technologies more attainable to employees so that employees don't waste time learning how to use them fairly, or get disappointed by leisurely interfaces or slow loading times (Raia, 2017). Following these steps will help companies overlook a spirit of cooperation and sustain high levels of efficiency among teams.

How Digital Culture and Work Practices Effect on Digital Employees Experience?

Digital workflows and technologies will have a important effect on the employee experience. With the improvement of technology and the growth of telework, digital workers are progressively active in the new workplace (Schneider and Kokshagina, 2021). It is significant for companies to constitute a digital culture that promotes communication, engagement and collaboration, among employees and provides them with the resources and tools they need to succeed (Gheidar and Zanjani, 2020). By raising a positive digital work culture, companies can develop employee productivity and satisfaction while remaining competitive in an ever-evolving digital environment. It is essential for organizations to change their experiences to meet the needs of digital workers and generate an enabling environment for them to succeed (Chandwani, Shah, & Shaikh, 2021). Digital workers are progressively playing a role in the new workplace. With the rise of telework and technology, digital cultures must be improved so that employees have access to the resources and tools needed to effectuate positive experiences (Raia, 2017). Companies that invest in generating a digital culture will benefit from increased employee team performance, satisfaction and productivity (Zel and Kongar, 2020).

In today's world, attainment to digital technology is necessary for businesses looking to remain competitive in an

continuosly developing digital work environment. Therefore, it is essential for organizations to constitute an efficient digital culture that supports association among employees while providing employees with the resources and tools needed to succeed (Daud et al., 2021).This includes establishing clear communication channels between team members as well as implementing strategies that promote engagement and motivation within teams (Meret et al., 2018). Additionally, developing processes for feedback collection allows managers to better understand how their team members feel about their work experiences; this data can then be used by companies when making decisions regarding changes or improvements in order to enhance employee satisfaction levels further (Joshi, Sekar & Das, 2023; Chandwani, Shah, & Shaikh, 2021). By investing time into creating an effective digital culture, organizations can reap significant rewards in terms of increased productivity and improved performance across teams.

What is Role of Individual Characteristics and Demographics on Digital Employees' Experiences?

The role of individual characteristics and demographics on digital employees' experiences cannot be ignored in the modern work landscape. It's important to note that a person's age, gender, and cultural background can shape how they perceive and engage with digital Technologies (Gheidar & Zanjani, 2021). For example, tech-savvy millennials find remote work more appealing, while baby boomers may struggle with the same setup due to their limited familiarity with digital devices (Sudrajat et al., 2021). In addition, personality traits such as openness to new experiences and tolerance influence employees and their reactions to digital transformation initiatives. Understanding and accepting these differences paves the way for a more inclusive and productive digital work environment (Beare et al., 2020). Therefore, it is important for companies to consider factors beyond technical skills when hiring and managing digital workers (Marsh, Vallejos, & Spence, 2022). The modern workplace is rapidly shifting from traditional to digital models,

requiring organizations to understand and embrace diversity among their digital workforce (Daud et al., 2021). Digital transformation initiatives have become the norm in many industries, and companies must embrace technologies such as cloud computing, artificial intelligence (AI) and automation to stay competitive. As these changes take place, it's essential that companies consider more than just technical skills when hiring and managing their digital workforce (Leo, Laud & Chou, 2023). The role of individual characteristics and demographics on experiences cannot be ignored; age, gender, cultural background, personality traits – all these factors can shape how an employee perceives and engages with new Technologies (Schneider & Kokshagina, 2021).

A study conducted by researchers at the University of California found that millennials were more likely than baby boomers to find remote working appealing due to being comfortable using technology-based tools (Beare et al., 2020). On the other hand, those born before 1960 tended not only lack tech literacy but also had difficulty adapting or troubleshooting technological issues which could lead them feeling overwhelmed by digital transformations initiatives (Meske & Junglas, 2021). In addition, having certain personality traits like openness-to-experience was associated with greater acceptance of new technologies among both millennials and baby boomers alike.

The concept of "flow", first introduced by psychologist Mihaly Csikszentmihalyi in 1975, is a state of being that can be experienced when someone is completely immersed in an activity. It is described as a feeling of energized focus and complete absorption in what one is doing (Marsh, Vallejos, & Spence, 2022). When someone experiences flow they become totally engrossed in the task at hand and lose track of their sense of time passing. This high level of engagement allows them to perform better than they usually would while also experiencing greater satisfaction from the activity (Gheidar & Zanjani, 2021). Flow has been linked to increased creativity, productivity, motivation and even happiness levels, making it an important phenomenon for people looking to maximize

their potential.he role of individual characteristics and demographics on digital employees' experiences cannot be ignored in the modern work landscape (Shahi & Sinha, 2020). It's significant to note that a person's cultural, gender and age background can shape how they engage and perceive with digital technologies (Daud et al., 2021). For example, technophile millennials may find teleworking more attractive, while baby-boomers may strive with the same installation time to being less familiar with digital tools (Schneider & Kokshagina, 2021). Intercalary, personality traits such as openness to new tolerance and experiences can affect employees and their reactions to digital transformation attempts (Meret et al., 2018). Understanding and accepting these distinctions can help create a more effective digital work environment. Therefore, it is significant for companies to take into account factors other than technical skills when hiring and managing digital employees (Sudrajat et al., 2021). The modern workplace is rapidly shifting from traditional to digital models, creating a need for organizations to understand and embrace diversity among their digital workforce (Ludike, 2018). Digital transformation initiatives have become the norm in many industries, and companies must embrace technologies such as cloud computing, artificial intelligence (AI), and automation to stay competitive (Raia, 2017). As these changes take place, it's essential that companies consider more than just technical skills when hiring and managing their digital workforce. The role of individual characteristics and demographics on experiences cannot be ignored; age, gender, cultural background, personality traits – all these factors can shape how an employee perceives and engages with new Technologies (Selimović, Pilav-Velić & Krndžija, 2021).

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transformations initiatives. In addition, having certain personality traits like openness-to-experience was associated with greater acceptance of new technologies among both millennials and baby boomers alike (Leo, Laud & Chou, 2023). Therefore it's important for organizations recognize these differences when

Dark side of Digital Employees' Experiences

In recent years, the rise and adaptation of technology has led to a significant shift from traditional employee experiences to digital employee experiences. Despite the immense advantages of these changes, there are several negative effects such technologies have on employees (Elizabeth et al., 2022). Numerous studies have investigated the impact of digitalization on employees, and six essential aspects have emerged as focal points (Selimović, Pilav-Velić & Krndžija, 2021).

Firstly, the increasing pressure for continuous learning and development has adversely affected employees (Beare et al., 2020). This is because workplaces must continuously keep up with technological advancements, resulting in an ongoing cycle of acquiring new skills. Consequently, the challenge of adapting and mastering new tools can lead to stress and burnout among employees (Marsh, Vallejos & Spence, 2022).

Secondly, digital employee experiences have raised privacy concerns among workers (Syahchari et al., 2021). The constant monitoring and data collection can result in employees feeling surveilled. This perceived lack of privacy may lead to heightened stress levels and poor job satisfaction (Bartsch et al., 2020).

Thirdly, the pervasive use of digital communication platforms has caused information overload for many employees (Sani et al., 2022). The growing number of emails, messages, notifications, and other alerts contribute to cognitive overload. This overstimulation negatively impacts mental well-being and hampers productivity.

Fourthly, technology dependence has created a culture that blurs the lines between personal life and work (Davison & Ou, 2017). Employees are expected to be available outside regular working hours resulting in constant "switching" between work-life roles. This boundary violation increases job strain and negatively impacts overall work-life balance (Park & Jex, 2011).

Fifthly, digital employee experiences often lead to unregulated screen time which can affect physical health (Elizabeth et al., 2022). Extended exposure to digital screens is associated with numerous health issues such as musculoskeletal complaints, eye strain, and general discomfort (Syahchari et al., 2021).

Lastly, the isolation that digital experiences bring can result in potential social disconnection (Marsh, Vallejos & Spence, 2022). With reduced face-to-face interactions, employees may experience a loss of camaraderie and social support within the workplace. This lack of human connection may lead to increased loneliness and mental health issues (Varshney, 2020; Elizabeth et al., 2022).

In conclusion, it is evident that digital employee experiences can have adverse effects on employees' overall well-being. Organizations should continue to innovate while ensuring employee welfare remains prioritized. Balancing the benefits of digital technologies with the negative impacts requires considering the holistic impact on an organization and its employees(Marsh, Vallejos & Spence, 2022).

Table 1 shows Elizabethetal.'s literature review on the dark sides of the digital employee experience.

Table 1. Empirical Studies on The Dark Side Effects and Associations Explored in The Literature (Elizabeth et al., 2022)

Dark side effect	Number of studies (percentage of empirical studies)	Associations explored
Technology-related stress	60 (40.8%)	Overload, disruption and distraction, addiction and excessive use, anxiety are all associated terms.
Overload	20 (13.6%)	As a source of stress and anxiety.
Anxiety	16 (10.8%)	As a cause of maladaptive technology use behaviors; as a symptom of stress; as a link between technology usage situations and poor outcomes; as a result of overload and work-family conflict.
Interruption and distraction	14 (9.5%)	As a cause of overload and stress.
Addiction or excessive use	13 (8.8%)	Interruptions, stress, and worry, particularly Fear of Missing Out
Work-nonwork issues (especially work-family conflict)	16 (10.8%)	Stress, overburden, and worry are all associated with it.

What is Result of Digital Employees Experience for Employees?

As technology continues to transform the way we work, more companies are shifting towards digital employees to streamline processes and improve efficiency. It's important to take a formative approach to answer this question as the results are still unfolding. While some experts say digital workers can offer advantages such as greater availability and remote workspaces, others say they can create conditions of disconnection and separation for workers (Gheidar and Zanjani, 2020). As these trends continue to grow, it is important for employers to carefully consider the impact of digital

workers on their operations and take steps to improve the employee experience (Raia, 2017).

The digital transformation of the workplace has become a hot topic recently as technology continues to change the way work is done. As many companies embrace automation and artificial intelligence, there is growing interest in how these changes affect employees (Cetindamar and Abedin, 2021). Some professionals say that the digital workforce can bring some advantages, such as greater remote and flexibility workplaces, while others point to disadvantages, such as separation and disconnection (Schneider and Kokshagina, 2021). It's clear that employers must consider carefully the implications of making this shift for their workforce if they want to ensure a positive employee experience overall.

One key factor in ensuring a positive employee experience during digital transformation is communication between employers and employees (Beare et al., 2020). Employers should provide frequent updates about any changes being made which affect staff, so that everyone knows what is expected of them and feels supported through the transition process. Additionally, it's important to offer training sessions or resources to help equip staff with the skills they need to be successful in their new roles or responsibilities - this will help boost morale by showing that you value your team members' development and progression within the company (Leo, Laud & Chou, 2023). Finally, it's essential to maintain regular contact with each employee even when working remotely; check-in calls or emails can go a long way towards helping.

In today's world, businesses are continuously exploring new technological advancements to enhance their operations. One of the most innovative and evolving concepts is the idea of digital employees. As artificial intelligence and robotics continue to grow, digital employees are becoming increasingly popular (Marsh, Vallejos, & Spence, 2022). However, the result of the digital employee experience can have profound effects on the success of a business. Whether it's improving customer service, increasing

efficiency, or reducing error rates, businesses that incorporate digital employees into their operations must ensure that the experience is effective and positive (Meske & Junglas, 2021). A poor digital employee experience can lead to a loss of productivity and ultimately, decreased revenue. Therefore, it is crucial for businesses to understand the importance of the result of the digital employee experience and strive to make it successful.

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CHAPTER IV

The Effect of Workplace Attachment Style on Work Behavior: Two Sides of The Coin

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Introduction

Based on the original theories of Mary Ainsworth and John Bowlby, assorted workplace interplay play an significant role in creating partnerships in organizational regulation (Scrima, Rioux, & Di Stefano, 2017). These types of attachments, including avoidance, anxiety and security can have a important impact on employee collaboration, work performance and communication. In this manuscript, we argue that employee's attachment style in the workplace has a through effect on productivity and work behavior, focusing on the consequentes of varied attachment styles for

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manager-coworker relationships and interactions (Mrázková and Lisá, 2022). Academic research theories and findings interested to attachment styles.

1. Secure Workplace Attachment: Individuals with this attachment type exhibit high levels of trust, empathy, and emotional intelligence. They have a strong sense of self-worth and are comfortable engaging openly and honestly with their coworkers. Securely attached employees often cultivate collaborative and supportive working environments Moffat, Rioux & Scrima, 2023).

2. Avoidant Workplace Attachment: People with avoidant workplace attachment tend to be emotionally distant and prioritize their independence above all else. They may struggle to build close relationships at work or rely too much on their own abilities instead of seeking input from their team members. This can lead to isolation and weaker bonds within the group (Pham et al., 2023).

3.Customer Preoccupied Workplace Attachment: Employees with preoccupied workplace attachment tend to exhibit excessive neediness or anxiety in their professional lives (Rioux & Pignault, 2013). They often display signs of emotional instability, putting immense pressure on their colleagues as they seek constant approval, reassurance, or guidance. This type of attachment can hinder teamwork by requiring coworkers to spend considerable time validating and supporting the preoccupied individual (Scrima, Rioux & Di Stefano, 2017).

Understanding workplace attachment types is crucial for creating high-functioning teams within an organization, as different styles of attachment can impact individual performance, teamwork dynamics, and overall organizational health (Ronen & Mikulincer, 2014). By recognizing these distinct patterns in employees' behavior, leaders can provide tailored support and resources to help them overcome potential challenges tied to their attachment style, resulting in more cohesive and effective teams.

Theoretical Background

Place Attachment

Place attachment, a psychological bond between individuals and particular locations, plays a crucial role in the understanding of human-environment relationships (Rioux & Pignault, 2013). This phenomenon involves an emotional connection to specific places, fostering a sense of belonging and identity with respect to that area. For instance, one may develop a deep place attachment to their childhood home or neighborhood due to the memories and experiences that have taken place there (Zhu & Lo, 2022).

Renowned environmental psychologist, Harold M. Proshansky, argues that place attachment not only contributes to personal identity but adds depth to our experiences with various environments. Hazan and Shaver, (1987) states, "A large part of who we are, in fact, resides in the spaces we have settled and continue to value. The more strongly these places resonate with us, the more completely do they become part of the structure that stores and sustains memories." This quote highlights the importance of place attachment as it asserts that our emotional ties with certain places contribute significantly to our memories and overall well-being (Luke, Carnelley & Sedikides, 2020).

In conclusion, place attachment is a vital aspect in exploring how humans interact with their environments (Scrima, 2020). The emotional bonds we develop with specific locations not only shape our personal identity but also influence our relationship with space (Murphy & Maynard, 2022). Through further exploration of place attachment concepts, researchers may uncover valuable insights on how to cultivate positive human-environment relationships and foster environments that cater to the well-being of individuals for generations to come (Venkataramani, Labianca & Grosser, 2013).

Workplace Attachment

Workplace attachment refers to the emotional bond and sense of belonging that employees develop with their work environment, colleagues, and organization (Scrima et al., 2015). This psychological connection has a significant impact on employee engagement, productivity, and overall satisfaction. As organizational psychologist Meyer and his colleague eloquently described it in his research, "attachment to the job is an affective bond and a sense of loyalty one feels for the organization" (Meyer, 1997).

Throughout the years, numerous studies have been conducted to assess the factors that contribute to workplace attachment (Pradhan & Mishra, 2020). Researchers have discovered that various aspects such as a supportive work environment, opportunities for growth and development, recognition of efforts, and shared values between employees and organizations are vital in fostering workplace attachment. One academic insight into workplace attachment comes from Halaby, who state: "Organizational culture is another crucial factor in sustaining workplace attachment; a strong culture enables employees to emotionally connect with the company's values and purpose." (Halaby, 1986).

A strong workplace attachment not only benefits employees but also benefits organizations by driving higher levels of performance, dedication, and commitment (Zhang et al., 2021). Employees who are emotionally invested in their workplace are more likely to stay longer with the company, reduce turnover rates, and contribute positively to the organization's overall success (Leiter, Day & Price, 2015). Higher levels of workplace commitment are linked to greater job satisfaction, commitment to organizational goals, and reduced intention to leave the organization (Scrima et al., 2015).

In conclusion, workplace attachment is an important psychological concept that has significant implications for both

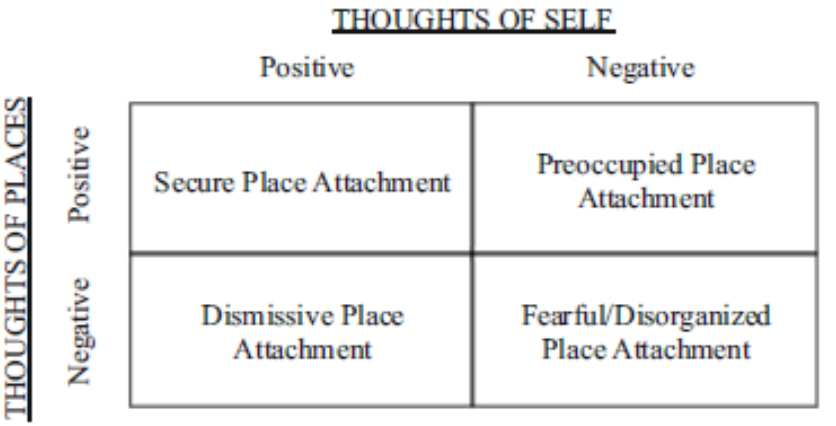
employees' well-being and organizational success (Pradhan & Mishra, 2020). By investing in developing a strong work culture and providing a supportive environment for growth and development, organizations can foster greater employee attachment resulting in positive outcomes for all parties involved (Ronen & Mikulincer, 2014; Mrázková & Lisá, 2022; Chinyamurindi & Shava, 2021).

Workplace Attachment Style

Workplace attachment styles refer to the ways in which individuals form emotional bonds and relationships with others at work (Untaru et al., 2023). These attachment styles are deeply rooted in the theory of attachment, which was first developed by John Bowlby and later expanded upon by Mary Ainsworth. According to this theory, our early experiences with caregivers shape our ability to form secure and healthy relationships throughout our lives (Bowlby, 1969; Rebillon et al., 2023).

In the workplace, attachment styles can manifest as secure, anxious-preoccupied, dismissive-avoidant or fearful-avoidant (Harms, 2011). Understanding these different styles enables managers and employees to foster healthier work environments and improve productivity. For example, securely attached individuals are more likely to exhibit trust, confidence and effective communication with colleagues (Gerber el al., 2020). Meanwhile, those with anxious or avoidant attachments may struggle with conflict resolution or experience higher workplace stress (Zhang et al., 2021).

In conclusion, workplace attachment styles play a crucial role in shaping interpersonal dynamics within work settings (Gonzalez, 2016). Recognizing these distinct patterns of attachment behavior allows for better understanding of individual needs in professional contexts Nonnis et al., 2022). By fostering awareness and promoting positive relationships among employees, organizations can create an environment where all members can reach their full potential while feeling supported by a strong network of colleagues.



Secure Workplace Attachment

Secure Workplace Attachment refers to the development and maintenance of positive, trusting, and supportive relationships within a work environment. It is a crucial aspect of organizational culture, as it fosters increased productivity and job satisfaction among employees. As noted by Hazan and Shaver (1990), "in the context of adult attachment, one can conceive of feelings for supervisors or even organizations as reflecting processes analogous to those that generate feelings for parents or other attachment figures in childhood." This academic quote emphasizes the importance of secure attachment in various aspects of life, including the workplace.

In a secure workplace attachment scenario, employees feel comfortable expressing their thoughts, concerns, and emotions without fear of negative repercussions from their supervisors or peers (Nonnis et al., 2022). They also feel assured that their needs will be taken into consideration and addressed appropriately (Moffat, Rioux & Scrima, 2023). An environment that encourages secure attachment allows employees to create strong bonds with their supervisors and colleagues (Rebillon et al., 2023). As Bowlby (1969) states, "Attachment behavior is any form of behavior that results in a person attaining or maintaining proximity to some other differentiated and preferred individual."

Establishing a secure workplace attachment leads to numerous benefits for both employees and organizations (Leiter, Day & Price, 2015). A supportive work environment enhances employee well-being, reduces stress levels, boosts morale, encourages open communication, nurtures teamwork and collaboration, and inspires innovation (Richards & Schat, 2011). Johnson (2022) argue that "employees' workplace attachment style affects not only how they relate to others at work but also how motivated they are to perform well." Consequently, higher levels of secure attachment are associated with more positive work outcomes.

In summary, Secure Workplace Attachment is an essential concept within organizational culture that creates an atmosphere in which employees can thrive both professionally and personally. The academic insights provided by Hazan & Shaver (1987), Bowlby (1969) and Mikulincer & Florian (1995) underscore the critical role it plays in shaping strong relationships among colleagues and producing desirable organizational outcomes. Developing and maintaining a securely attached work environment should be a priority for businesses striving to achieve balance, productivity, and success.

Avoidant Workplace Attachment

Avoidant Workplace Attachment refers to a pattern of behavior in which individuals tend to distance themselves emotionally from their work environment (Ye et al., 2022). This detachment often stems from past experiences that have led an individual to prioritize self-reliance and independence over the development of close relationships with coworkers and supervisors. In this scenario, they might avoid forming deep connections or engaging in collaborative workspaces, fearing vulnerability and rejection (Mrázková & Lisá, 2022).

This type of behavior can negatively impact an individual's professional growth and the overall functioning of a team (Leiter, Day & Price, 2015). When employees are reluctant to communicate

openly with their peers or superiors, essential information may not be shared effectively, leading to misunderstandings and inefficiencies within the organization. Additionally, employees who display avoidant workplace attachment are more likely to exhibit lower job satisfaction and higher levels of stress due to both interpersonal conflicts and feelings of isolation (Luke, Carnelley & Sedikides, 2020).

In conclusion, Avoidant Workplace Attachment is a pattern of emotional detachment from one's work environment deeply rooted in past experiences (Zhang et al., 2021). It affects not only individual performance but also teamwork and communication among colleagues (Richards & Schat, 2011). It's essential for organizations to recognize the signs of avoidant attachment in employees and create a healthy work environment that encourages open communication, collaboration, and relationship-building among team members to improve overall productivity and employee well-being (Untaru et al., 2023).

Preoccupied Workplace Attachment

Preoccupied workplace attachment refers to a state of mind where employees experience a high level of anxiety and fear in their work relationships, often anticipating rejection or failure (Scrima, Rioux & Di Stefano, 2017). This type of attachment is characterized by a lack of security and trust in the workplace, which can lead to decreased employee satisfaction and overall well-being. According to attachment theory experts Dr. Mario Mikulincr and Dr. Phillip R. Shaver, attachment anxiety refers to chronic concerns about the availability and responsiveness of attachment figures and persistent worries about rejection or abandonment. (Mikulincer and Shaver, 2007).

In this context, employees with this attachment style may have difficulty committing to colleagues, superiors, or the workplace. (Scrima, Rioux & Di Stefano, 2017). They feel reluctant to make decisions without consulting others. Additionally,

difficulties may arise in expressing emotions and oneself (Zhu and Lo, 2022).

The conclusion of anxious work engagement are not restricted to psychological and individual well-being, but also stretch to performance and organizational (Moffat, Rioux, & Scrima, 2023). Researches has shown that employees with major attachment anxiety tend to have inferior job satisfaction, productivity, general communication problems and more likely to lose intentions in the work place (Hazan and Shaver, 1987; Zhang et al., 2021; Untaru et al., 2023; Leiter, Day & Price, 2015). Futhermore, insecurely attached to employees may find it inconvenient to build supportive relationships with their colleagues due to apprehension about rejection (Zhang et al., 2021).

Moreover, work engagement is a complicated establish that effects individual organizational performance and well-being. Adopting human resources management experiences that focus on practice developing communication skills and emotional intelligence can alleviate the negative effect of insecure attachment at work life(Bruny et al., 2023; Johnson, 2022). Employers must prioritize fostering a inclusive and safe work environment where employees can improve without attachment anxiety.

The Importance of Workplace Attachment Style

The significance of diversified attachments in the workplace cannot be overemphasized, as they play an substantial role in assigning the attribute of interpersonal relationships between colleagues. Attachment styles, such as insecurity, anxiety, and avoidance, influence the way individuals interact with each other and affect their ability to work together and achieve shared goals (Chen, Wen, & Wu, 2021). Knowing and understanding these types of attachments is essential to create a positive and collaborative work environment (González, 2016).

A secure attachment style at work plays an important role in developing strong and cohesive teams that can perform well under

pressure (Scrima, Rioux, & Di Stefano, 2017). Employees with secure relationships are more likely to engage in open communication, to trust their work friends, and to be fair with their team (González et al., 2018). This security consent them to make deeper contacts with others and better navigate disagreements when they arise. According to Sroufe (2005), employee who experience sensitive and anticipatory treatment are able to create resilient work patterns for the effectiveness and availability of support.

On the other hand, anxiety and avoidance of extracurricular activities at work lead to lack of communication, mistrust and division among colleagues (Ronen and Mikulincer, 2014; Chinyamurindi and Shava, 2021). These individuals may struggle to form strong bonds with team members or may become preoccupied with perceived threats or rejections from others (Scrima et al., 2021). Their heightened sensitivity to interpersonal cues can disrupt not only their own productivity but also interfere with group dynamics as a whole. Mikulincer et al., (2003) state that "employees with anxious attachment styles tend to be preoccupied with rejection and abandonment by significant others, whereas those who are avoidant tend to suppress their emotions and detach themselves from social interactions".

In conclusion, recognizing the importance of workplace attachment style is crucial for managers and team members alike as it directly impacts the efficiency and effectiveness of a team. A deeper understanding of these attachment types will help you improve communication, improve conflict resolution, and create effective strategies for managing diverse employees. Additional examples (González, 2016). Finally, by creating a safe and supportive work environment, companies can optimize the performance of their teams and improve overall productivity. (Nonis et al., 2022).

The Impact of Workplace Attachment Style on Relationships with Co-Workers and Team Members

The impact of workplace attachment styles on relationships with coworkers and team members is an important part of organizational success because it affects employees' ability to work together (González, 2016). Various attachments, created by past life experiences, have been shown to have an impact on people and their lives. communication patterns, peer perceptions and overall performance (Gerber et al., 2020; Rioux and Pignault, 2013).

People who connect securely in work environments are confident in their communication and interpersonal skills. They like to open up to their colleagues, receive feedback, and create an environment of trust and cooperation (Luke, Carnelley, & Sedikides, 2020; Mrázková & Lisá, 2022). However, people with insecure attachment styles may have difficulty forming strong relationships with their partners.

In their research, Luke, Carnelley and Sedikides, (2020) have identified that anxiously attached individuals often display a heightened need for approval in the workplace. They may be prone to feeling a strong sense of dependency on their co-workers' acceptance and validation while avoiding genuine feedback. On the other hand, avoidant individuals frequently present emotional detachment from colleagues and resist sharing personal opinions or ideas (Meyer, Becker & Van Dick, 2006). This distance can act as a barrier among team members, resulting in reduced collaborative efficacy and unproductive work settings.

In conclusion, attachment styles established early in life have long-lasting consequences that extend into the workplace domain. Understanding the impact of these styles on relationships among employees can help provide insight into various organizational dynamics. Acknowledging these differences can pave the way for more tailored interventions targeted at fostering healthier work environments that ultimately lead to enhanced team performance.

The Impact of Workplace Attachment Style on Relationship with The Manager

The impact of workplace attachment style on the relationship with the manager is a significant factor affecting employees' overall work experience and performance. As Bowlby's (1969) attachment theory posits, "The propensity to make strong emotional bonds to particular individuals [is] a basic component of human nature." In the context of the workplace, attachment styles that individuals develop during their early years have a significant influence on how they relate to their managers, forming the foundation for trust, communication, and collaboration (Murphy & Maynard, 2022).

An individual's attachment style can be broadly categorized into secure, avoidant, and anxious. Securely attached individuals tend to have positive working relationships with their managers as they are comfortable seeking support and feedback when needed (Moffat, Rioux & Scrima, 2023). According to Mikulincer and Shaver (2007) "a secure relationship in adults was found to be incorporated with better relationship stronger and expectations collaboration." As a result, employee job performance and satisfaction increase based on their capability to communicate openly and directly with their managers.

Moreover, employees with attachment styles often have complexity building close relationships with their managers due to fear of trust and rejection. Halaby (1986) stated that "avoidants are characterized by a propensity to trust oneself and doubt others." As a result, these employees may have complexity asking for sharing or guidance worry with their managers, which can lead to communication low job satisfaction, problems and isolation.

On the contrary, employees who have a sense of devotion often have a powerful desire to be close to their managers, but are troubled by fear of disrespect or abandonment. Chinyamurindi and Shava (2021) observed that "anxiously attached individuals are characterized by a constant need for reassurance from others about relationship security." Thus, anxiously attached employees may

engage in excessive reassurance-seeking behaviors or can become overly dependent on their manager's approval, which may strain the working relationship and negatively affect job performance.

In conclusion, individuals' workplace attachment styles significantly influence their relationships with their managers. Securely attached employees typically have more satisfying working relationships, while avoidant and anxious attachment styles often lead to communication challenges or unproductive dependency dynamics. Employers can benefit from understanding and identifying these attachment patterns among employees to foster better communication and develop supportive managerial strategies tailored to each individual's needs.

Conclusion

The benefit of recognizing employees' workplace attachment types to their relationships with the workplace and colleagues is multifaceted. By understanding the various attachment styles demonstrated in the workplace, employers can foster a more supportive and engaging work environment (Mrázková & Lisá, 2022; Moffat, Rioux & Scrima, 2023). Attachment theory, originally developed by Bowlby (1969), posits that individuals develop internal working models of self and others based on early experiences with caregivers. These models shape individuals' expectations and behavior in close relationships, including those formed with colleagues and supervisors in the workplace.

One significant benefit of recognizing employees' attachment types is an enhanced ability to predict employees' responses to various workplace situations. For instance, individuals with secure attachment styles may exhibit higher levels of trust in their employers and coworkers, leading to greater collaboration and job satisfaction (Mrázková & Lisá, 2022). In contrast, those with insecure attachment styles may struggle with trust issues, resulting in decreased performance or dissatisfaction (Hazan & Shaver, 1987).

Recognizing these differences allows employers to address them proactively and create a more harmonious work environment.

Another benefit of recognizing employees' attachment styles lies in informing professional development strategies. Research has shown that secure attachment correlates positively with worker adaptability (Pradhan & Mishra, 2020). making securely attached individuals more likely to be receptive to changes in job responsibilities or new information(Leiter, Day & Price, 2015; Chinyamurindi & Shava, 2021). By understanding employees' attachment types, supervisors can tailor their training programs and leadership approaches to ensure that they cater effectively to each employee's unique background, fostering a more efficient learning process (Rebillon et al., 2023).

Lastly, acknowledging the importance of employees' workplace attachment styles facilitates stronger interpersonal relationships between coworkers (Untaru et al., 2023). Understanding colleagues' attachment styles helps team members navigate potential conflicts with greater empathy and compassion for one another's perspectives. This increased knowledge not only bolsters working relationships but also contributes to a more positive organizational culture as a whole (Scrima, Rioux, & Di Stefano, 2017).

In conclusion, recognizing employees' attachment types is crucial for fostering a positive and productive workplace environment. It enables employers to predict employee behavior, optimize professional development opportunities, and facilitate strong coworker relationships that contribute to an uplifting organizational culture.

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CHAPTER V

Innovation and Consumer Innovation

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Introduction

Innovation has become the main driving force of sustainable growth and social welfare for today's economies. Innovation, which has such an important role for the national and global economy, is undoubtedly considered as an important concept for productivity,

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profitability and performance increase for the enterprises in the economic system. In parallel to its contribution to economic development, innovation can also be said to bring dynamism to the development of social welfare and living standards of individuals (Uzkurt, 1:2008).

Innovation is a concept that affects the whole of life, changes and transforms life in all areas of life from individual to society. The competitive environment in commercial life has led to a change in the position of consumers in the market. The concept of innovation also changes and transforms the policies of consumers and businesses towards consumers.

Innovation brings about a change and this change becomes meaningful when analyzed together with other concepts. Concepts related to innovation include change, invention, technology, research and development, entrepreneurship and creativity (Karaaslan and Akdoğan, 2013:1).

In this section, the concepts of innovation and consumer innovativeness are examined in detail. As the sub-headings of the study, the concept of innovation, types of innovation, the concept of consumer innovation, consumer innovation types and the adoption levels of consumers' innovations are included.

Literature Review

In the national and international literature, t h e r e are many studies on consumer innovativeness. Some of these studies are included in this section.

Roger and Shoemaker (1971) defined innovativeness as "the degree to which an individual adopts an innovation relatively earlier than other members of his or her system". Hirschman (1980) tried to present a conceptual framework by combining three important issues related to consumer behaviour (behavioral innovativeness, novelty seeking and consumer creativity). Two aspects of innovativeness were mentioned in the study. Rogers and Shoemaker (1971) see

innovativeness as a relatively earlier degree of adoption. Midgley and Dowlig (1978) defined innovativeness as the degree to which an individual is open to new ideas and makes innovation decisions independently. Goldsmith and Hofacker (1991) stated in their study that one of the most important problems in studies on innovativeness is the reliable and valid measurement of innovation. Manninget al. (1995) associated the concept of innovativeness with the process of adopting a new product. They then developed a scale to measure *consumer's independent decision-making* and *consumer's search for innovation*. Goldsmith et al. (1998) tried to understand the transnational consumer response to products and innovations offered in international markets with the theory of consumer innovativeness and developed a new scale in this regard. Roehrich (2004) critically analyzed different definitions of consumer innovativeness and developed a different scale. Tellis et al. (2009) analyzed the consumer innovation criteria of the top 15 countries in the world economy. According to the results of this study, they emphasized that similarities and differences of consumers are important in global markets. They also stated that consumer innovation contributes to the economic progress of countries.

Nasution and Garnida (2010) examined three aspects of consumer innovativeness (product categories, predisposition and general characteristics of the individual). Hoffmann and Soyez (2010) a d d r e s s e d t h e *productcategory* dimension, which has not been addressed in previous studies.

Bartels and Reinders (2011) analysed 79 articles on consumer innovativenessand r e c o m m e n d e d that innovativeness should be handled in different dimensions. Bartels and Reinders (2011) analyzed 79 academic studies within the scope of ISI index and considered innovativeness in three dimensions and developed a new scale.

Akdoğan and Karaaslan (2013) demonstrated the meaning of consumer innovativeness and its change in the historical process on a model. Kaushik and Rahman (2014) examined consumer

innovativeness with the dimensions of innate innovativeness, domain-specific innovativeness and innovative behaviour. Bülbül and Özoğlu (2014) examined the relationship between consumer innovativeness and purchase behavior and perceived risk. According to the results of the research, they stated that there is a positive relationship between consumer innovativeness and purchasing behavior, but a negative relationship between consumer innovativeness and perceived risk, perceived risk and purchasing behavior. They stated that innovativeness has a sales-increasing effect on the consumer's purchase decision, while risk perception has an important determinant effect on sales reduction.

Kim et al. (2015) examined the relationship between experiential brand factors and innovativeness. In this study, they concluded that post-purchase behaviours are important determinants of consumer innovativeness. Mishra (2015) examined consumer decision styles and stated that this is an important factor in marketing, especially in market segmentation studies. Kuswati (2018) reviewed the literature on consumer innovativeness and presented different measurement models. In his study, Özden (2019) examined the relationship between consumers' social approval needs and innovation and concluded that taking into account consumer wants and needs affects consumer behavior related to the new product. Eryiğit (2020) triedto predict the future directions of consumer innovativeness. In a study conducted in Finland (Nikou, 2019), it was stated that consumer innovativeness significantly and positively affects the intention to use smart home technologies. Similarly, consumer preference for electric vehicles differs according to the level of innovativeness of consumers. (Morton et al., 2016). In the study conducted by Zhang et al. (2020), findings on howproduct innovation and perceived value and consumer innovativeness affect willingness to pay were included. Pan et al. (2021) suggest that marketsegmentation and market segmentation should be considered in order to preventfailure in innovation studies of enterprises.

They drew attention to the importance of target positioning. (2022) examined electric vehicle purchasing behavior within the scope of consumerinnovation and stated that marketing strategies should be developed for the adoption of these vehicles.

1.CONCEPT OF INNOVATION

1.1.Definition and Importance of Innovation

The efforts of businesses to act with the latest technology and the efforts of entrepreneurs to seize new entrepreneurial opportunities throughout the entire entrepreneurial process are considered as initiatives (Hıdıroğlu, 2021: 6). In today's economy, it has become important to influence consumers withnew products and new perspectives in a changing and intensifyingcompetitive environment. In this sense, innovation has become an effective competitive tool to differentiate from competitors. This situation has led to the emergence of different definitions of innovation (Deniz, 2012:3).

The word innovation, as the equivalent of the French and English word *innovation*, means "innovation, invention, renewal. Innovation was first defined by economist and policy scientist Joseph Schumpeter in his book written in 1911. Various definitions have been made about innovation, whichwas defined by Schumpeter as "the driving force of development" (Ekşi et al.2008:13). One of them is the definition made by Everett M. Rogers in his book "Diffusion of Innovations". According to Rogers, innovation is defined as an idea, practice or object perceived as new for an individual or a unit (Rogers, 1983:135). Apart from these, Schmookler (1966) defines innovationas a technical change; Steele (1975) defines innovation as a process of creating a change; Barutçugil (1981) defines innovation as a process inwhich new and useful information is presented to the market; Roberts (1987)defines innovation as a set of efforts in which new ideas become operational; Drucker (1995) defines innovation as a change tool that enables a

different product and service or managerial skill for organizations (Deniz, 2012:4-5).

Apart from these studies, the Oslo Manual published by the OECDdefines innovation as "Innovation is the application of a new or significantly improved product, service, process, new marketing method or workplace in the organization or external relations" (Oslo Manual, 2005:46).

1.2.Concepts Related to Innovation

The definitions of innovation have led to the use of new concepts. These concepts can be listed as invention, change, creativity, technology, research and development, entrepreneurship (Deniz, 2012:8, Baykal, 2019:6).

1.2.1.Invention

The discovery of a new idea or asset used in production or offered to the market within the innovation process is considered as invention (Danışman, 2015:144- 145). Invention can be defined as an action, a process developed to create something new (Joshi, 2017:87).

In this respect, it can be said that innovation benefits from inventions. However, innovation aims to discover ways to create value, not to invent the undiscovered, and requires commercial success (Elçi, 2016:17). For thisreason, the benefit-creating feature of innovation includes the commercialization of inventions as well as their transformation intoapplicable and usable forms. The commercial aspect of innovation is themost important feature that distinguishes it from invention (Trot, 2002:28)

Thanks to invention, employees often work harder, longer and more productive. They produce innovative solutions to problems, develop cost- reducing processes or profitable new products (Anderson et al, 2014:73).

The relationship between innovation and invention has been the subject of limited number of studies. In order to contribute to the study of the strong relationship between innovation and invention, it needs to be analyzed conceptually. In addition to other factors, invention and innovationtendencies are also examined in measuring the development levels of countries.

1.2.2.Change

When the concept of change is evaluated within consumer innovativeness, it is seen that it gains meaning in an integral relationshipwith the concepts of creativity and innovation. In order for the innovation in the product or service to achieve its purpose, a series of changes such as organizational policies, organizational structure and increasing theperformance of employees should take place (Deniz, 2011: 147).

Change is a metamorphosis that can be observed over time in the transition from a disliked state to a desired state, which changes the structure of society and changes the relationship of human potential with means and purposes.

is a process that determines as a whole. In order to talk about change, thereshould be continuity, new needs should arise and the problem that will arisewith the change should not turn into a chaos (Sargın, 2003:103-104). Inaddition, change and innovation should not be confused with each other. While innovation is accepted as a process covering the whole organization,change corresponds to a more limited area occurring in any of the processes within the organization (Deniz, 2012:9).

1.2.3.Creativity

Creativity, which is seen as a psychological aspect of behaviour, has many definitions in the literature. According to Higgins, creativity is the pratical use of knowledge or the recombination of knowledge with a method that adds value (Higgins and Morgan, 2000:118). Therefore, creativity should include useful

new ideas or applicable ideas that will serve to solve problems (Mumford, 2000:314).

In the definitions of creativity, although the relationship between creativity and innovation leads to similar definitions, there is a clear distinction between these two concepts in the literature (Yeloğlu, 2007:148). While innovation is defined by Amabile, Conti, Coon, Lazenby, Erramilliand many other researchers as the implementation of ideas, creativity is defined as the emergence of these ideas. Therefore, creativity is accepted as the process necessary for the emergence of innovation (Sigala andKyriakidou, 2015:297).

Creativity climate in organizations provides many benefits. It both increases the satisfaction of employees and improves the competitiveness of the firm. The competitive advantage that can be achieved through creativityis important for businesses. As a result of a research conducted by IBM in 2010, creativity was identified as the most sought-after characteristic in leaders (Anderson et al, 2014:73).

1.2.4.Technology

Not every innovation has to involve a technology. Technology can be supportive for innovation or it can emerge as a result of innovation. Therefore, there is a cyclical relationship between technology and innovation. Although technology and innovation are used interchangeably, infact, technology is seen as a result of innovation; materials, tools, equipment,methods used for more effective and efficient use of new developments in the production and delivery of goods and services (Günay & Çalık, 2019: 9).

When the literature studies are taken into consideration, technology is accepted as a combination of products, tools, equipment, plans, techniques and processes which are accepted as physical and management, marketing, production, quality control, qualified labor force which are accepted as components of knowledge. Technology is a process that associates the product

development process with knowledge. Therefore, technology and knowledge should be considered in relation to each other (Wahab, 2012:62). In addition, technology should be considered as a mental phenomenon together with physical equipment (Deniz, 2012:10).

1.2.5.Research and Development (R&D)

Today, creating competitive advantage is possible not by offering standardized products to global markets to which everyone has relatively equal access, but by creating new products, services and processes and making them marketable. It is a fact that productivity, growth and competitive advantage cannot be achieved in the knowledge economy without establishing a continuous, market-oriented R&D and innovation process that shares and contributes to the regional and global knowledge stock. R&D and innovation is defined as the ability to transform science and technology into marketable new or more advanced products, systems, production methods and social services. In our age, enterprises that can demonstrate their competence in science and technology in innovation or that can sustain their competence in innovation by feeding it with their competence in science and technology can achieve competitive advantage in world markets.

R&D is the activities aimed at producing a new product, improving the quality and/or standard of the existing product, applying new methods to reduce costs, developing a new technology that can be applied in the market in relation to production, and transforming the results of these into useful tools, equipment, materials, products, methods, systems and production techniques or improving them with existing technology.

Scientific and technological developments are accepted as an indicator of the development of countries. R&D activities are important in evaluating the importance given to scientific and technological developments. The size of the budgets allocated to R&D activities is accepted as one of the criteria taken into consideration in measuring the development of countries (Işık &

Kılınç, 2011: 9). In order for innovation activities to be meaningful, technological innovation should be supported by innovation in marketing (Zerenler et al., 2007: 662).

1.2.6.Entrepreneurship

The understanding of competition of the age also affects the conditions and environment of the market. This situation increases the importance of innovation and entrepreneurship concepts. The entrepreneur has to benefit from innovations in order to be successful. This shows that there is a mutual, interactive relationship between innovation and entrepreneurship. Entrepreneurship is needed in the realization of the purpose of meeting the needs of the market inherent in innovation (Şahbaz, 2017: 30).

Entrepreneurship can be defined as the discovery of new products and services, production processes and their utilization in a way to create opportunities. From this point of view, entrepreneurship offers an economic opportunity for situations that have not yet been sufficiently evaluated and uncertain (Cuervo et al., 2007:2). From an economic point of view, it is seen that the definition of entrepreneurship used today has changed depending on the changing production style. In economic terms, the activity of mobilizing resources is accepted as entrepreneurship (Aytaç, 2006:141).

1.3.Types of Innovation

The concept of innovation is a comprehensive concept, so the classifications made vary. The types of innovation frequently mentioned in the literature are as follows (Baykal, 2019:10):

- Product innovation
- Service innovation
- Process innovation
- Marketing innovation

- Organizational innovation
- Radical innovation
- Incremental innovation

1.3.1.Product Innovation

Changes in the characteristics of products or improvements anddevelopments made to differentiate the way the product is used are product innovation.

(Özaydın and Boyraz, 2021:860). Product innovation is related to the production of new products to obtain new markets and customers or toprotect and satisfy existing markets and customers (Wan, et al., 2005:262). Product innovation reflects the developments in the product mix of the enterprise, new product options and their development. Product innovation is generally realized in technology-oriented enterprises and helps enterprises to improve their competitive position and maintain their existence in the market(Kılıç, 2013:58). The shortening of product life spans by production techniques that are differentiated by technological developments makes product innovation and sustainability of innovation compulsory (Çavuş, 2006:117).

1.3.2.Service Innovation

Service innovation, as in product innovation, covers the process of introducing new services in order to obtain new markets and customers or to protect and satisfy existing markets and customers. (Wan, et al. 2005:262) It can be said that service innovations are less formal than product innovations (Köse, 2012:15).

The characteristics of the products and their physical similarities necessitate the provision of additional services and new values in order to protect customers and gain new customers. At this point, service innovation is seen as an important variable of competition in order for businesses that are sensitive to their

customers and the demand of the market to compete (Deniz, 2012:33). With service innovation, it is aimed to use technologies that will increase the performance of the service provided and to improve organizational capabilities (Hıdıroğlu, 2021:187).

1.3.3.Process Innovation

Process innovation is the process of improving the production processes of the products or services produced or introducing these products and services (Wan, et al., 2005:262). Therefore, process innovation is also seenas the development of different ways of manufacturing and providing services (Ganzer, et al., 2017:3). This situation occurs in the form of usingthe same amount and quality of labor force in an enterprise to produce more products and services with the same quality. Since process innovation coversa wide process from the purchase / production and storage of a product to its sale and delivery to the customer, it aims to reach the target with newmethods and increase efficiency (Baykal, 2019:10).

With the applications of enterprises for process innovation, savings will be achieved in raw materials, energy, time and personnel employment, thus taking important steps towards reducing costs and improving quality. Inaddition to these benefits, customers will be able to access products and services more easily, quickly and easily. In particular, process innovationwill provide enterprises with significant competitive advantage by producing more effective solutions to overcome the problems encountered in the protection of patents (Ise, 41: 1995).

1.3.4.Marketing Innovation

For businesses, innovation and the introduction of new products and services to the market is one of the main factors determining development as a driving force. However, underlying the failure of most of the products and services offered to the market is the fact that consumer needs are not met. Therefore, market

segmentation and distinguishing innovative consumers from other consumers is an important issue in introducing innovative products to the market. In this sense, marketing strategies become important (Pan, Xin and Li, 2021:1).

Marketing activity has an important place in the acceptance and development of new products, services and ideas. Marketing innovation is accepted as the application of a new marketing method with all its elements including the marketing process of the product. The acceptance of customer- oriented innovations in marketing innovation practices is important in terms of competition (Turan, 2017:8).

Since this whole process will require a stronger and healthier communication with the consumer, it is possible to say that the marketing innovation has achieved its purpose if the services offered to the consumer are perceived as a value by the consumer (Karaaslan, 2012:9).

1.3.5.Organizational Innovation

Organizational innovation, unlike other innovations, is an innovation thatexpresses the cultural power of the enterprise in a sense, which is needed for the initiation and implementation of the talent, new products, ideas that the organization needs for innovation, not products and processes. Therefore, organizational innovation refers to the opening of the enterprise to newmarkets with innovative behaviors at the point of offering a new product, service or idea to the market (Baykal, 2019:14). In other words, in the commercial activities of the enterprise, the organization of the workplace

The use of a new organizational method in external relations is considered asorganizational innovation (Deniz, 2012:36).

With organizational innovation, changes and developments in the personnel policies of enterprises are expected to contribute to and support other innovations. The innovations to be made within

the scope of organizational innovation are expected to contribute to reducing the costs of the business and increasing customer satisfaction (Timuroğlu & Yılmaz,2021: 321).

1.3.6.Radical Innovation

Innovations made in the form of developing a product, service, processor method that did not exist before and transforming it into a benefit are called radical innovations. Radical innovations usually lead to significant changes in an individual's life and behavior. Radical innovations are usuallycarried out by small firms and help them enter the sector and offer significantadvantages in competing with other firms in the sector. (Uzkurt, 19:2017)

Radical innovation is the changes made outside the routine in the execution of activities (Wan, et al., 2005:262). In other words, incorporating a new technology into the business, adopting a management style different from the existing management types of the business (Baykal, 2018:15),making decisions that require great financial risk are considered radicalinnovations. In this case, radical innovation can be associated with technological and market uncertainty.

The introduction of a technological innovation that has not yet been proven and commercialized is an important risk faced by radical innovation. Another difficulty with radical innovation is that the product may be perceived differently by users other than the existing users. Therefore, it is necessary to solve the problems experienced due to the new technology and to educate the customers (Kararaslan, 2012:12). With radical innovation,new products and services and new methods are developed. Therefore, radical innovation is accepted as an attempt to bring an innovation to the market (Şahbaz, 2017: 24).

1.3.7.Incremental Innovation

Incremental innovation is innovations that are made without deviating much from existing organizational activities and business

activities and are part of routine changes (Wan, et al., 2005:262). Therefore, innovations, improvements and small-scale changes brought to an existing product, service or process are considered incremental innovations (Türk, 2012:20). In other words, incremental

With innovation, it is aimed to serve an innovation by improving the existingproduct and service or process. This process, which is evaluated whether it will be accepted as an innovation depending on the conditions, is carried out with minor changes (Bayındır, 2007: 243).

Incremental innovations are also understood as the strengthening of the existing practices of the enterprise with small corrections and non-radical innovations. In addition, unlike radical innovation, incremental innovation avoids decisions that will lead to significant changes in the situation ofbusinesses in the market. Therefore, the data obtained from customers andthe experiences obtained from the existing product or service are seen as the factors that are effective in the emergence of incremental innovation (Köse, 2012:22).

2.THE CONCEPT OF CONSUMER INNOVATION

2.1.Consumer Innovation

Consumer innovativeness was explained by Rogers and Shoemaker inthe 1970s as "the level at which an individual adopts a new idea relatively earlier than other individuals in his/her social system" (Kayabaşı and Özkan, 2020:160).

The concept of innovation has also been used instead of the concept of "consumer innovation". However, with the researches trying to understand the tendencies of consumers, the concept of consumer innovation has started to attract attention as an independent concept (Danacı Şenbabaoğlu, 2020: 53).

Consumer innovativeness is the tendency of consumers to adopt innovations (Tellis et al., 2009: 1). According to another definition, consumer innovativeness is the tendency of consumers to want to have new products and brands that they have not yet used (Jordaan and Simpson, 2006:33).

Midgley and Dowling define consumer innovativeness as "a person's decision to innovate independently of other people's communication experiences and the degree of openness to innovations". In the early days, researchers focused on the time of adoption of innovation. Midgley and Dowling "s definition of "making an innovation decision independently of other people "s communication experiences" differs from the previous definition at this point. They criticized that innovations have a dimension and argued that innovation cannot have a dimension (Akdoğan and Karaaslan, 2013: 4; Midgley and Dowling, 1978: 235).

2.2.Types of Consumer Innovation

The classification of consumer innovativeness started as personal and product-based innovativeness and then different consumer innovativeness started to take place in the literature. Consumer innovativeness in the literature are personal innovativeness, product-based innovativeness, fashion innovativeness, functional innovativeness, hedonic innovativeness, social innovativeness, cognitive innovativeness and behavioral innovativeness. (Yeşiltuna, 2023:51).

2.1.1.Personal (Innate) Innovativeness

Personal innovativeness is defined as the degree to which an individual's decisions about products and services are not dependent on the experiencesof other individuals. It is the personal and independent acceptance of innovations without experiencing and experiencing within the social class to which a person belongs. Personal or innate innovativeness argues that a person has an innate

innovative character and has an inherent innovative personality (Aytekin and Çopuroğlu, 193: 2021)

Personal innovativeness guides individuals in the purchase of new products and services and can be generalized for all product and service purchases. In other words, personal innovativeness is also defined as innovative tendency or innovation seeking tendency (Deniz, 2012:63).

2.2.2.Product Based Innovation

Although the impact of many factors on the success of new products and services introduced to the market is known, the level of consumer readiness for innovation and the extent to which the innovation meets the expectations of customers is an important issue (Bartkowiak and Michalak, 2020:14616).

Product-based innovation refers to the consumer's tendency to acquirethe product or service as a result of the level of interest between innovation and the product (Aydın, 2009:191).

In the product-based innovation approach, people's tendencies to adopt new products and to obtain information about new products come to the fore.Individuals' interest in new products is felt much more strongly in the fields of fashion and technology. Another prominent issue in product-based innovation is the perceptions and attitudes of the consumer depending on the product category. Apart from fashion and technology, social identity is a significant aspect of product innovation.

It is accepted as one of the functions in product innovation because it affects the level of product innovation (Deniz and Erciş, 2016: 465)

2.2.3.Fashion Innovation

Although fashion itself is an innovation, fashion innovativeness is a type of innovativeness used to determine the tendencies and acceptance levels of individuals regarding products

and services that can be called new fashion. Individuals with high fashion innovativeness tendency are considered to be active and social individuals. This tendency is seen as one of the basic consumer characteristics (Özçiftçi, 2015:138).

Changing consumer tendencies from time to time, the choice of any object is seen as fashion. It aims to increase the company revenues of new fashions spread by fashion innovation and to raise awareness of customers' satisfaction with the product they buy compared to consumers who do not buy the product. It is considered important to understand the buying behaviour of customers and to develop better marketing techniquesaccordingly. Fashion innovation is considered to be an important determinant in investigating the customer's willingness to buy. It is also believed by experts that fashion is of critical importance for customers (Mohamed and Wee, 2020:51,54).

2.2.3.Functional Innovation

It is the type of behavior that consumers evaluate with its functional dimension in innovative product preference and prefer useful products. In functional innovation, consumers are influenced by time saving and convenience in their processes. For this reason, consumers are not emotional and pleasure-oriented, but value a utilitarian function.

Innovative consumers who buy new products based on their functional aspects are in this group. These functional aspects include usefulness, compatibility, efficiency, comfort, ease of use, quality and reliability.

2.2.4.Hedonic Innovation

It is the type of innovativeness that states that hedonic purposes are effective on the basis of individuals' purchase of goods or services. Hedonic innovativeness argues that individuals' purchasing actions change with the level of pleasure they get from shopping and should be evaluated within consumer characteristics in

this respect (Koç et al., 2017: 236). When expressing the dimension of hedonic innovativeness, it is defined as enjoyingthe novelty of the product or service.

The urge to accept innovations with hedonic behaviors such as buying istaken into account (Vandecasteele and Geuens, 2010: 309).

2.2.5.Social Innovation

Today, consumers are in contact with both companies and other consumers and can influence each other's decisions. Therefore, the positionof customers for businesses is not only to be the buyer of the company's products. It is now recognized as part o f a value creation process in which the consumer is included. (Bartkowiak and Michalak, 2020:14616). Thus,the effort to create value is expected to serve the benefit of society.

Definitions of social innovation differ in the literature. According tosome researchers; i t i s accepted as a type of innovation that contributes to technological innovation to increase competitiveness. Some other researchers define social innovation as the service of innovations and improvements in cultural, economic and social aspects of the society to the progress of the society (Halaç et al., 2014:167).

An example for social innovation is using renewable energy to be sensitive to the environment. All studies for the development of renewable energy technology can be evaluated within the concept of social innovation. The widespread use of the Internet and e-commerce transactions and even voting on the Internet can be considered as important developments in terms of social innovation. The main purpose of social innovation is to meet the needs of society. Social innovators are individuals, while social innovation describes a social process (Üzüm and Şenol 2019:583).

2.2.6.Cognitive Innovation

Cognitive innovativeness is a type of innovativeness that explains the motivation involving the individual's exploration, understanding and creativeaspects with mental stimulation based on cognitive goals. In other words, cognitive innovativeness is the desire for experiences that mobilize and stimulate the mind. According to this innovativeness, the individual considers a number of advantages and disadvantages when purchasing a product or service (Şahin, et al., 2021: 309).

Cognitive innovativeness emphasizes rational thinking and problem solving approach in the evaluation of the consumer's view on innovation.

It creates new experiences and products. This situation encourages consumers to try new experiences and products (Akdoğan & Karaaslan, 2013: 6).

2.2.7.Behavioral Innovation

Behavioural innovativeness, another name of which is "innovative behavior", is the type of innovativeness that occurs as a result of the consumer using a product or a service that he/she has previously used for certain purposes for other purposes. This type of innovativeness shows the tendency to reuse. If a new product or service is used for an old purpose, behavioural innovativeness is also mentioned (Kambar, 2016:92).

In behavioral innovativeness, the degree to which the consumer adopts the innovation in question is taken into consideration. The most important factors in determining behavioral innovativeness in consumers are the number of goods and services purchased in the previous month and behavioral characteristics such as past shopping experience (Soutar and Ward, (2008: 2).

3.CONSUMERS' LEVEL OF ADOPTION OF INNOVATIONS

Consumers who are the buyers of goods and services in the market differfrom each other in terms of the speed of adoption of innovations. Rogers categorized consumers in five different categories as *Innovators, Early Adapters, Early majority, Late majority* and *Laggards*. The innovation adoption groups categorized by Rogers (1983) and their characteristics are asfollows.

Innovators: They are the first to try new products and services in the market and like to experiment. They are not afraid of technology. Consumersbelonging to this group are very willing and pioneering in adopting innovations. This leads them out of their local peer networks and into more cosmopolitan social relationships. Although the geographical distance between innovators is significant, communication patterns and friendshipsare common among a group of innovators. Although innovators are not respected by other members of the social system, the innovator plays an important role in the diffusion process.

In general, it consists of consumers who are courageous and risk-loving, challenging, have sufficient financial resources to cover the damages caused by innovations, have the ability to understand and apply complex technical information and have the ability to cope with the high level of uncertainty that the innovation will bring. This group a c t s as a locomotive in the diffusion of innovations.

Early Adapters: Early adopters are a more integrated part of the local social system than innovators. While innovators are cosmopolitan, earlyadopters are usually locals.

Although the people who make up this group do not have the material resources of innovators, they are respected by the social system and are seen as the embodiment of the successful use of new ideas. The early adopter knows that he/she has to make sensible innovation decisions in order to continue to earn the respect of his/her colleagues and to maintain his/her central position in the communication structure of the system. Most membersof the social

system rely on the early adopters' experience with innovations. In many social systems this group is dominated by opinion leaders. Early adopters are seen by many as "the person to consult" before using a newidea. They make wise and prudent innovation decisions.

The vast majority of potential buyers receive and use innovations after the early adopters have received and used them. They thus minimize the risk for later adopters and share their experience of the innovation with other members of the system. If the early adopters are successful with the innovation, the probability of full adaptation of the social system to the innovation increases.

Early Majority: The most important characteristic of this group is that they are more cautious than the previous two groups. Their decision-making time takes a longer time than innovators and early adopters. They emphasize their logical motives when choosing products. They prefer the product or service not because it is new or different, but because it is more functional, more economical, more practical or more reliable than existing products in the market and better satisfies their needs. They collect more informationand evaluate many alternatives. They conduct more extensive research to eliminate doubts about the product. People in the early majority act as a link between the early adopters and the late majority

Late Majority: They are often skeptical, cautious and reluctant to accept innovations. Their adoption of innovations often takes place soon after the adoption of the majority of the members of the social system. This group adopts innovations due to increased social pressure, and this adoption is largely driven by a significant elimination of risks and uncertainties associated with the product or service. This is mainly due to below average income levels.

Laggards: This group is at the bottom of the social class. They are the last to adopt innovations in the social system and this takes a long time. Theylook at innovations skeptically and show a significant resistance in thisregard. During the period when this group adopts innovations, new technologies or new products have already entered the market. They have an isolated life style in the

society, their education and income are low. They have a philosophy of life based on traditions and skeptical about innovations. The group they are in contact with is usually their own social class. This situation increases the resistance to innovations even more.

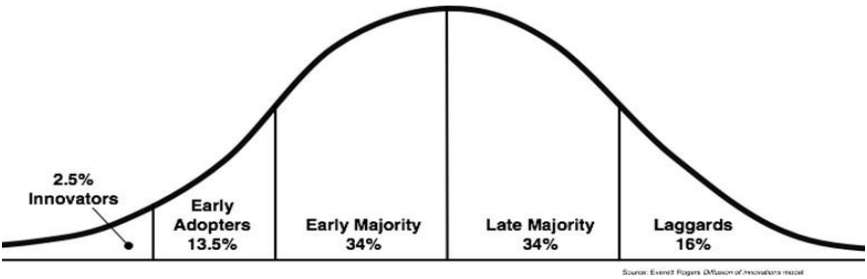

Figure:1 Groups in the Adoption of Innovations

As seen in Figure 1, it is seen that the early adopters and the early majority group constitute a significant part of the innovation adopters. In this model, innovators remain as a marginal group. According to Rogers "smodel, socio-economic status, social classes, tendencies, thought structures, personality and behaviors of the groups adopting innovations differ from each other and Rogers summarized these differences as follows (Rogers, 1995:269-274).

From a socio-economic point of view, he stated that the social status, education and social mobility of the groups that adopted innovations earlier were better than those who adopted innovations later, and that these two groups differed from each other in terms of social class in the society they lived in.

When these two groups are evaluated in terms of personality, it is stated that early adopters are more rational and intelligent, more competent in dealing with uncertainties, more open to change, more enthusiastic about education, career, etc. and less fatalistic than late adopters.

When evaluated in terms of communication behaviors, the early adopter groups were more social and active, more competent in self-expression, more successful in communicating

with the society, more knowledgeable about innovation and more inquisitive than the late adopter group.

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