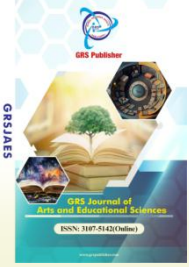
OPEN ACCESS

GRS Journal of Arts and Educational Sciences
Abbreviate Tittle- GRS J Arts Edu Scin
ISSN (Online) - 3107-5142
https://grspublisher.com/journal-details/GRSJAES

Vol-1, Iss-2 (Aug- 2025)



A Review of the Knowledge Management Framework in International Technology Transfer

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Received: 06.07.2025 **Accepted: 05.08.2025** **Published: 13.08.2025**

Abstract: The basis of technology demand and its transfer at the international level is the knowledge gap that exists between the supplier and the importer of technology. A deep understanding of this gap can better meet the demands of international technology transfer, enable it to be carried out more effectively using information technology tools, and reduce the time and costs of transfer. This article also identifies the stages of international technology transfer along with the types of knowledge gaps.

Keywords: *knowledge management, tacit knowledge, explicit knowledge, international technology transfer, knowledge gap*.

Cite this Article

Dr. Mehmet. U, A Review of the Knowledge Management Framework in International Technology Transfer (2025) *GRS Journal of Arts and Educational Sciences , Vol-1(Iss-2).17-22*

Introduction

Today, the importance of knowledge in international technology transfer is well recognized by government and private sector managers. However, minimal research has been conducted in our country on this subject, even though many organizations are engaged in transferring technology to other countries, and many others are importers of technology from different parts of the world.

Our country is no exception to this trend, as we are both a technology transferor and a technology importer in industries such as oil and gas, steel, and automobiles.

This article attempts to explain the existing gaps in knowledge management in international technology transfer, considering the stages of transfer or acquisition, and to provide recommendations to domestic companies—both technology adopters and technology transferors—to fill these gaps. This study also examines how knowledge transfer is managed by companies using information technology, as well as the problems they may encounter.

The results of the research indicate that the use of information technology enables organizations to record, process, and distribute knowledge appropriately among users. Businesses operate in a knowledge-intensive environment; therefore, it can be said that knowledge is the most important capital of an organization. Every organization has its own specific and relevant knowledge that improves operations and can play a unique role in achieving competitive advantage.

A prerequisite for successful operations in a knowledge-intensive environment is the effective management of knowledge in that environment. Effective knowledge management can facilitate rapid access to current and relevant knowledge required for multiple tasks in order to improve decision-making, and it allows necessary knowledge and information to be found and shared throughout the organization.

In the literature, knowledge management encompasses the general activities of collecting, organizing, sharing, applying, utilizing, compiling, and documenting. Through a systematic process supported by information technology, knowledge management enables an organization to create, acquire, distribute, and use structured and illustrated knowledge to achieve organizational goals by improving performance.

To implement international technology transfer, resources such as production technology, process technology, and know-how or advanced skills related to project management, operations, and problem-solving are required. This also involves planning and implementing a series of technology transfer process activities. The technology transfer process involves a series of ordered and organized decisions and continuous activities, which together serve as the appropriate input to bridge the technological gap between the importer and the technology transferor.

Statistics from the 1990s show that technology transfer has often been inadequate because technology management is a complex process that must be carefully executed to achieve the goals of technology transfer projects. The main reason for this inadequacy is the knowledge gap between the technology provider and the technology recipient. Successful knowledge management can improve the efficiency and effectiveness of the international technology transfer process. However, knowledge management in international technology transfer is quite complicated because the process of transferring technology from an industrialized country—where the technology in question is already

established—to a developing country with an emerging economy must bridge a large gap.

Scientific research has shown that the introduction of technology does not necessarily lead to the acquisition of technological knowledge and competence in international technology transfer projects. Recent developments in information technology can help alleviate some of these problems. The increase in computer processing power and the variety of advanced software have accelerated the creation of knowledge, as well as the analysis and organization of raw data. This has also sped up the convergence of computing and communications technology in the dissemination of knowledge.

As a result of the integration of transfer systems—through the Internet, extranets, and Enterprise Resource Planning (ERP)—managers have been able to communicate easily with others throughout the organizational environment. Al-Obeidi's research in 1999 identified that companies involved in the process of international technology transfer (ITT) have used information technology tools to control the technology transfer process, but there has been little research on the methods of using these tools to achieve the desired knowledge.

Research by Nahara found that high-tech companies in countries with advanced industries that use various IT tools and global networks (such as educational CDs and DVDs, effective multimedia, software-based simulation tools, educational web pages, multimedia extranets, open communication channels, e-mails, and video conferencing technology) are more successful. However, the role of knowledge management in international technology transfer activities has not been clearly defined.

Other research has also been conducted in this field, but it has focused more on explaining how the process occurs. This study seeks to approach the issue from a new perspective and to identify the less-explored aspects of this subject by providing insights and recommendations for managers and companies involved in providing and adopting technology.

Research Literature

Technology Transfer and Knowledge Management

Technology has multiple definitions. In other words, technology is a diverse and complex phenomenon consisting of logical processes and systematic, purposeful physical interactions that are embodied in physical objects (such as machines and tools) or human beings (such as the knowledge of engineers or technicians). Applied knowledge is related to physical processes in production or process technologies, while logical processes refer to the knowledge of how to operate a machine.

Although the skills and expertise required to install, configure, repair, maintain, and make effective use of tools or machinery are also considered know-how or advanced skills , in most cases, technology transfer requires the transfer of knowledge related to physical processes (physical components such as digital components) as well as know-how or advanced skills related to their configuration.

Knowledge is divided into two categories: tacit and explicit knowledge. Explicit knowledge refers to detailed plans, designs, diagrams, specifications, and other materials. Explicit knowledge is relatively easy to codify and is therefore more easily transferred to others with the support of information technology. In contrast, tacit knowledge is difficult to codify and is not usually documented in organizations.

Plani was the first to introduce the concept of tacit knowledge. His famous phrase in this context was: “We know more than we say.” Antoly pointed out that, because information technology has a limited capacity to transfer tacit knowledge, it is generally used to transfer explicit knowledge.

Knowledge can also be categorized in other ways, but in this study we focus on this classification. Generally, information technology researchers work primarily with explicit knowledge management; however, in this research we deal with both explicit and tacit forms of knowledge.

Processes to enhance the perception, production, operations, marketing, and business capabilities of a company.

Technology transfer is a learning-oriented and advanced process compared to the simple movement of physical products. Researchers believe this process has four main dimensions: capacity, connections, appropriate context, and consequences—these constitute the core activities of the process.

Academics, like consultants, suggest that knowledge-related capabilities are successfully managed when the context for knowledge management has been developed. In particular, the development of information technology has made it possible to store, edit, and transfer large amounts of knowledge. This accessibility has also been extended to technology transfer projects at any time and in any place.

Scientific research and achievements over the past two decades have made it possible to easily overcome time and geographical barriers through communication technologies. These advancements also facilitate cooperation, coordination, and knowledge sharing between technology providers in industrialized countries and technology recipients in developing countries. Once a dynamic technology transfer knowledge pool is created, the technology provider can make it available to those who will benefit.

By using information technology during the implementation of technology transfer activities, individual knowledge can be processed. The general activities of the international technology transfer process that facilitate knowledge management and knowledge linkage include the following:

1. Research on the international market for technology transfer.
2. Selection of a technology recipient.
3. Identification of the technological needs of the technology recipient.
4. Selection of the appropriate technology for transfer.
5. Negotiation and contracting.
6. Execution of the technology transfer project mission.
7. Evaluation.

Study on the Topic

The basis of technological demand is the knowledge gap between the requester and the technology provider. To clarify the issue, it is better to first analyze the knowledge gap model between the technology supplier and the technology importer (Figure 1).

This model identifies four gaps between the technology importer and the technology supplier. The first gap exists between the level of knowledge expected by the recipient and the level of knowledge intended by the technology supplier.

It is possible that the supplier intends to transfer knowledge of a technology, while the requester is seeking a systemic understanding of that technology. The second gap is the difference between what is decided to be transferred and what is actually transferred. It is possible that the knowledge transferred is less than what was originally planned. For example, it may be decided that a systemic understanding will be transferred, but in practice, only an advanced skill level is transferred.

The third gap is the difference between the intended level of absorption and the actual knowledge acquired. What is desired is not always the same as what is ultimately absorbed. Finally, the fourth gap represents the difference between the knowledge provided and the knowledge absorbed. The provider may have a high actual ability to transfer knowledge, but the conditions and opportunities for absorption may not be available. Conversely, the receiver may be ready to absorb any type of knowledge, but the transferor may lack the capabilities or conditions for effective transfer.

Now that the knowledge gaps at different levels for the technology receiver and adopter have been identified, we aim to create a deeper understanding of the impact of knowledge management on international technology transfer.

In this study, we seek to answer the following questions:

- In each aspect of a technology transfer process, how does information technology support overt and covert knowledge—compiled, distributed, and used?
- How can the gaps be reduced?

Many studies have been conducted on knowledge management and its role in information technology, and all of these studies aim to deepen the understanding of this phenomenon. The data collection tools used in these studies are questionnaires and interviews.These studies have mostly focused on companies with advanced technologies that transfer technological information to developing countries through technological support, emphasizing the challenges surrounding this process.

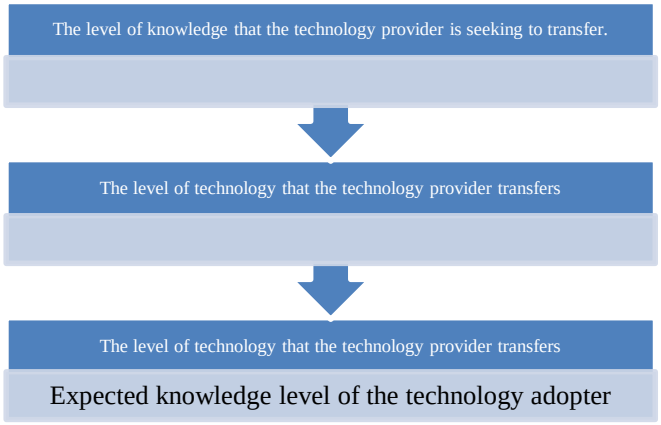

Figure (1): Knowledge Gap Model Between Technology Supplier and Importer

The questionnaires and interviews in this research seek to determine:

- In which aspects of information technology that support the international technology transfer process is knowledge stored, distributed, and used?
- In each aspect of a technology transfer process supported by information technology, how is tacit and explicit knowledge codified, distributed, and used?
- What problems arise in compiling, distributing, and utilizing tacit and explicit (hidden and explicit) knowledge in each of the main aspects of the technology transfer process?

In general, it can be said that there is often a gap in understanding knowledge transfer between the technology-receiving company and the technology-transferring company, because the demands are not always the same as what is actually transferred.

Therefore, it is advisable to make selections with careful consideration of the conditions of the other party. After the selection, the necessary conditions for the acceptance and transfer of explicit and implicit knowledge should be ensured.

The knowledge gap and the approach to knowledge management are issues shared by both the recipient and the technology transferor. Therefore, the following steps and recommendations should be considered for both the transferor and the recipient of technology, with the support of information technology.

International Market Research for Technology Transfer

It is better for the technology recipient company to examine the transferor's background and capabilities and to make the necessary assurances regarding the matching and bridging of the knowledge gap with itself. It is recommended to further evaluate the transferor's research and development unit to determine how knowledge management works and how knowledge is distributed, shared, and applied during technology transfer. Ensure that proper research in this case can cover the first type of gap well.

Choosing a Technology Adopter or Provider

It is better for technology transfer companies to pay more attention to the opportunities created around the world, to further examine the level of capabilities and knowledge of the counterparty to anticipate the necessary capabilities for knowledge management during technology transfer, and then to select their counterparty. There may be times when heavy investment in information systems is required to redesign business processes, increase information technology infrastructure for processing and distribution, and its cost-effectiveness for both the technology transferor and the technology importer is unavoidable for a successful technology transfer.

The traditional method involves traveling to a country that accepts technology and sending information and knowledge through hardware, while the new method involves the use of both hardware and software.

The Internet, extranets, video conferencing, online database services available on websites, e-mail, teleconferencing, and the use of software for processing, distribution, sharing, and utilization will significantly reduce both the cost and time of technological transfer involved in information technology support, and distances will also be reduced.

Technology importers should also consider the gaps in supplier decision-making, which will help ensure successful technology transfer.As mentioned, the use of information technology tools will significantly reduce time and cost, but sometimes face-to-face meetings are unavoidable.

Sufficient precision in both the selection of the recipient and the selection of the technology transferor is effective in reducing the first and third types of gaps.

Technology Selection for Technology Transfer

To fill the desired gap and provide the appropriate technology along with the knowledge needed by the counterparty, it is better to select the right people to carry out the organizational mission. Information technology allows us to examine employee database profiles more quickly and accurately, and also to communicate with them more efficiently, provide them with the necessary tasks, or train them.

Some cases have been observed where knowledge transfer, along with technology transfer, has been incomplete due to inappropriate selection of individuals, and the aforementioned knowledge gap has not been filled well and expectations have not been met. After selecting individuals, it is best to conduct research on the level and type of technology to be transferred. It is necessary to use a database of past transfers to select the level and type of technology to be transferred. In many cases, technology transfers that exceed expectations due to problems in implementation or maintenance create problems in later stages. Research and reflection on this topic can reduce the first type of knowledge gap.

Negotiation and Agreement

In the traditional way, the number of trips to the receiving or transferring countries is high, and the result includes information related to the transfer context, communications, aspects and consequences, and satisfaction arising from the technology transfer process. Negotiations for technology transfer usually last several months, during which the terms of the contract regarding what is to be transferred are analyzed thoroughly, including its legal aspects. Usually, even after the contract is signed, questions or issues arise for the parties, which often result in the travel of managers, and the first type of gap often arises at this stage. New methods that use videoconferencing and electronic mail are proposed and emphasize the processing, distribution, and use of information. With the appropriate distribution of knowledge, the level of access will be properly defined, and certainly, the issues and problems that arise will be fewer.

Accomplishing the Mission of the Technology Transfer Project

It is obvious that with the increase in the knowledge of the technology recipient, the information and knowledge gap between the two parties will decrease. Therefore, it is recommended to increase the information technology capabilities of the technology recipient so that the technology provider can conduct training faster and with higher quality. In addition to increasing the knowledge on the technology recipient side, this action creates the opportunity for the technology provider to transfer the desired technology and knowledge at a lower cost.

The fourth type of gap is observed more in this section. To better implement the technology transfer project, the following resources can be used:

- Network-based information technology.
- Project control software appropriate to the volume of information available in the project.
- Appropriate operating system.
- Use of Enterprise Resource Planning (ERP), which is recommended for companies with multiple parallel projects or short time frames.
- An operating system that is both user-friendly and technology-transferrable.
- Appropriate data distribution through the database used.
- Videoconferencing systems for meetings and training.
- Use of other software such as CAD/CAM, SolidWorks, Mechanical Desktop.
- Employees outside the country are better off connecting to the network via Serial Line Internet Protocol (SLIP) or Point-to-Point Protocol (PPP).

Technology Package Preparation

The proposed technology package includes the physical components and knowledge required by the recipient of the technology that the transferor proposes. In order to increase the subsequent technological capabilities related to possible problems and shortcomings, it is better to transfer tacit or implicit knowledge along with it. It is very difficult to transmit tacit knowledge through a technology package. The second and third types of gaps are more visible at this stage. Proper knowledge management and timely provision of the right knowledge, at the right time and place, are very important in the transfer of a technology package. Perhaps it is impossible to say that a technology package is complete without considering the transfer of tacit and implicit knowledge. It is better to transfer the categorized knowledge required by the technology user along with sending the pieces via videoconference, Internet, CDs and DVDs, and extranet. This knowledge is related to the units of engineering systems, quality systems, management systems, marketing systems, sales, and specialized knowledge of production and service delivery, which must be appropriately compiled, categorized, and made available to users.

Updating the Knowledge and Engineering Capabilities of the Existing Force

In some technological matters, the technology on the receiving side is outdated and needs to be updated. It is better for the technology transferor to transfer the engineering capabilities and knowledge to the desired level. Proper performance at this stage will reduce the knowledge gap in the fourth stage.

Project control software is used throughout the technological update. This software is mostly related to the way and timing of allocating financial resources, time, human resources, and equipment, but generally, this software does not consider knowledge resources and how to compile, distribute, and when to use them. It is better to identify explicit knowledge and, in some cases, tacit knowledge, and to specify how to allocate knowledge appropriately in the transfer of high-volume transferable technologies.

It is also better to design and create multimedia software for training technology adopters during technology transfer and to teach project management discussions, modeling, operational analysis, and evaluation.

Knowledge management re-examines appropriate communication within the organization and defines the proper communication so that information and knowledge can be transferred from the defined parts of the technology transferor to the undefined parts of the technology receiver. Information technology tools allow tacit knowledge to be transferred to an acceptable level, in addition to explicit knowledge.

Evaluation

During the technology transfer process, the technology provider is willing to monitor the outcomes of the technology transfer, which includes discussions such as technology performance and identification of technology transfer problems. For this purpose, it is necessary to use appropriate tools to check them and to share information, to ensure that these technology transfer measures meet expectations.

Proper knowledge management is essential to prevent duplication of work, to ensure necessary and correct controls at the right time, and to organize and send reports accurately and systematically.

This also prevents errors. In order to transfer knowledge and solve problems that arise, the use of teleconferences and videoconferences for knowledge exchange, accompanied by time and cost savings, seems inevitable.

In most cases, the questions raised about the lack of explicit knowledge are not obvious because explicit knowledge is easily transferred. The use of information technology tools leads to the smooth exchange of tacit knowledge.

Presentation of the Model and Conclusions

As mentioned, the companies providing and receiving technology initially have a knowledge gap between them. In the best transfers, this gap is well covered. This gap is due to the difference in knowledge in both types—both overt and covert. It is preferable that before, during, and after an international technology transfer, the technology provider places the experiences gained from previous technology transfers in an integrated database of web pages so that it can be accessed by those in need and shared among them by defining the appropriate level of access.

Similarly, it is better for companies requesting technology to consider a database of suppliers, their backgrounds, capabilities, and available conditions. They can also conduct initial discussions and pre-contract consultations via video and teleconferences. Before starting the project, define the level of knowledge you want to achieve, select the people to reach that level, and define access levels based on tasks. It has also been shown that information technology enhances collaborations to compile and distribute knowledge globally, regardless of geographical, temporal, and cultural boundaries. It is recommended that multimedia software be used to transfer tacit knowledge, as explicit knowledge transfer is easily accomplished.

In this study, in order to bridge the technology gap between the technology provider and the technology recipient, we have broken down the process of international technology transfer with the support of information technology to identify the contribution of knowledge management in each of these components.

It has been widely observed that technology recipient countries have not only bridged this gap well, but have also been able to become creative and innovative in that technology after a short period of time.

To gain tacit and explicit knowledge from the technology transfer process, one must provide the context for absorbing the desired knowledge. The level of knowledge we intend to have after technology transfer depends on the initial mission and our definitions of the technology transfer process.

Efforts should be made to define the details and timing of knowledge acquisition in advance, and the necessary capacity for absorption and storage should be foreseen and provided for in order for this process to be carried out successfully.

As can be seen, the process of technology transfer is always affected by knowledge management in order to bridge the existing scientific and technological gap between the recipient and the technology transferor. The technology transfer process has stages such as feasibility, identification of the importer's needs, selection of appropriate technology, negotiation and agreement, and the end result is technology transfer and evaluation.

These stages are common to both the supplier and the recipient of the technology. As can be seen in the figure, capacity, platform, connections, and outcomes form the basis of technology demand and the transfer process, with which technology suppliers and importers are constantly interacting.

Conclusion

In this study, the knowledge gap in the international knowledge transfer process was analyzed, and the existing knowledge gaps between the technology supplier and importer were introduced. The stages of technology transfer and the types of gaps were also examined, and suggestions were made for managers to use information technology to reduce knowledge gaps and ensure successful technology transfer.

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