Emerging Technology

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September 25, 2023

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Technology is a mathematical theory, an algorithm, a method, a hardware device or a software which is developed for certain purposes. One important goal of a *technology* is that it can be applied in (i) solving a problem which has ever been solved, (ii) aiding to solve a problem or (iii) improving our living or work.

1.1 Definition

Technology management is a management process covering (1) the management of the usage of technologies with access right granted for work, (2) the management of the development of a new technology and (3) the management of the access right of the new technology.

For comparison, the definition of management could be stated by the same principle in the following. *Management* is a process covering (1) the management of the usage of resources with access right granted for work, (2) the management of the development of a new resource and (3) the management of the access right of the new resource[1].
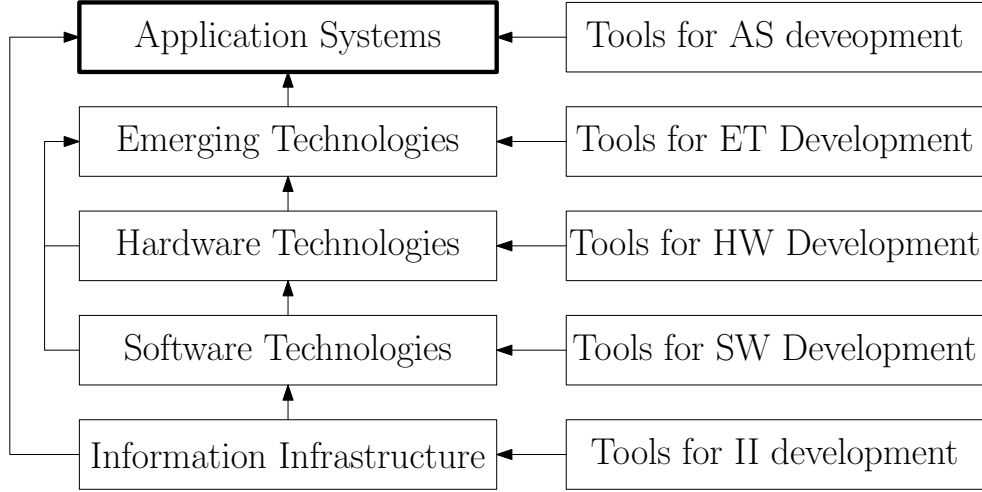
1.2 Implications

Thus, technology management is a problem dependent managing process. The set of technologies to be acquired depends on the problem to be solved. If the professional who handles this management process is called the technology manager, a technology manager would need to be capable to understand the scope of a problem to be solved and then decide which technologies have to be used.

A technology manager would need to bargain for the accessibility of such technologies. If a technology to be used has not yet been developed or the technology is not accessible, the technology manager would need to determine its specification for the development team to make it. Once the new technology has been developed, the technology manager would have to understand how difference it is as compared with other similar technologies in the market and the new technology should be filed in patent. Once the new technology has been patented, licensing on the use of the new technology should be managed by an independent professional team in the firm.

1.3 Technology manager

Under such circumstances, a technology manager should be knowledgeable in a number of areas, namely (1) the technical details of the technologies potentially for use in solving problems; (2) the managing the process of technology development; (3) technology development; (4) the design of the licensing policy for each new technology being developed; (5) the recruitment of the professionals to assist the technology manager to complete all those tasks. Furthermore, a technology manager should also be knowledgeable in (6) marketing and (7) making strategic decision on the future technology development and the usage of technologies. Last but not the least, a technology manager should be (8) able to design the operations for all these tasks. To equipped with such knowledge and skills, what courses a pre-technology-manager should acquire?

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[1]For human resource management and financial management, their definitions are similar. (a) *Human resource management* is a management process covering (1) the management of the usage of human resources with access right granted for work, (2) the management of the development of a new human resource via training and coaching; and (3) the management of the access right of the new human resource. (b) *Financial management* is a management process covering (1) the management of the usage of financial resources with access right granted for work, (2) the management of the development of a new financial resource via investment and (3) the management of the access right of the new financial resource.

Application Systems	←	Tools for AS deveopment
Emerging Technologies	←	Tools for ET Development
Hardware Technologies	←	Tools for HW Development
Software Technologies	←	Tools for SW Development
Information Infrastructure	←	Tools for II development

All of them are emerging technologies.

Figure 1: Landscape of emerging technologies. All the technologies included in the blocks are emerging technologies. They include the application systems and the technologies being developed; and the tools for developing such systems and technologies.

2 Emerging Technology

The definition of *emerging technology* is essentially the same as the definition of *technology. Emerging technology is a collection of mathematical theories, algorithms, methods, hardware devices and software which are developed for (i) solving a problem which has ever been solved, (ii) aiding to solve a problem or (iii) improving our living or work. Emerging technology refers to the set of technologies which are available in nowadays and in near future. These technologies have been developing for many years and have been applied in many areas. In near future, these technologies and their advancements are hardly be replaced by any new technology.*

Figure 1 shows the landscape of emerging technologies. It covers the technologies developed to support application systems. Moreover, the tools developed to aid the development of the application systems and the emerging technologies are themselves emerging technologies. Usually, a manager only looks at the available application systems and selects from them the appropriate systems for the business operation being managed. For a more capable manager, he or she should look at the available application systems and the emerging technologies. If there is no suitable application system available for use, the manager should be able to design and manage the development of a new application system with the appropriate emerging technologies.

Emerging technology also embraces a collection of thousands of technologies. Today, 5G, WiFi, ChatGPT and Google Bard are emerging technologies. However, in four hundred years ago, they were not.

2.1 Emerging technology in the 17th century

In the seventeenth century, there was no electricity (respectively, computer). Can you imagine how people managed accounting information in that period of time? What technologies had been used for managing accounting information? Can you imagine how people made a shirt in that period of time? What technologies had been used for making a shirt? Obviously, all these works had to be done by people manually aided with various different tools. The tools included human workers, paper notebooks,

abacuses, metal locks, pigeons, horses and the imperial post offices. Thus, these tools were the emerging technologies at that period of time.

2.2 Emerging technology in today

Today, Siri and Google Assistant are emerging technologies. They could be used as voice recognizers for the users to command a computer-based information system to perform data analysis and reporting. Google Translate is an emerging technology for online translation. The AI model embedded in the Google Translate is yet another emerging technology. Auto-Drive vehicle is an emerging technology. The real-time video processing system in the auto-drive vehicle is an emerging technology. The real-time image understanding system in the vehicle is also an emerging technology. Blockchain is an emerging technology. It could be applied to develop other emerging technologies for use in financial sector and health care sector.

2.3 Intelligent services and intelligence infrastructure

Today, Siri and FaceID are two intelligent services. Intelligent service is a service delivered to users and each intelligent service might have applied multiple emerging technologies, like communication technology and intelligent technology. Various tech giants have released a number of intelligent services on their cloud platforms. Here are some examples[2].

- IBM Cloud – Watson Speech to Text, Watson Text to Speech, Watson Language Translator, Watson Visual Recognizer, IBM Watson Services for CoreML, etc.

- Amazon AWS – Amazon Lex (voice-to-text), Amazon Polly (text-to-voice), Amazon Rekonigtion for image analysis, Amazon Machine Learning, etc.

- Microsoft Azure – AI Services like Azure Cognitive Services and Azure Machine Learning; AI Tools and Framework; and AI Infrastructure, etc.

- Google Cloud – Cloud Vision API, Cloud Intelligence API, Natural Language API, Cloud Translation API, Speech-to-Text API, Text-to-Speech API, Tensor Processing Unit (TPU), Google Bard, other Cloud ML services.

- OpenAI – ChatGPT.

These cloud platforms delivering intelligence services would serve as the intelligence infrastructures for the development of higher level of intelligence application systems, as shown in Figure 2. To ensure that the intelligence services are deliverable, information infrastructure has to be accessible in 24/7 manner. So that, user device[3] is able to connect to the information infrastructure via Internet at anytime and anywhere.

If we consider that the intelligence infrastructure includes the (1) intelligent technologies, the (2) hardware and (3) software technologies specially developed to support the intelligent technologies, an overall picture on intelligent service delivery and intelligent service development could be shown in Figure 3. Each block on the left hand side corresponds to a collection of technologies. Each block on the right hand side corresponds to a collection of development tools for technology development. One should be noted that some development tools might have applied intelligent technologies.

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[2]https://www.eweek.com/artificial-intelligence/aiaas-companies/.

[3]In recent years, user device is technically called an edge device. A limitation of this edge device is that its computational power is not sufficient to support all computational processes in an AI application. One AI application mentioned is the Siri. An iPhone must have the Internet access and then the iPhone is able to connect to the corresponding server in the Apple Cloud and let the server to complete the NLP processes and return the result to the iPhone. In other words, the iPhone is just a terminal device connecting to a powerful server for the Siri service.
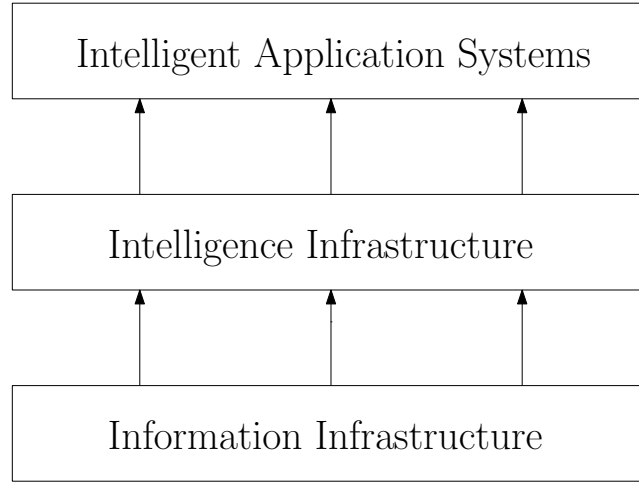
Figure 2: Intelligence infrastructure advocated by Michael I. Jordan [1].
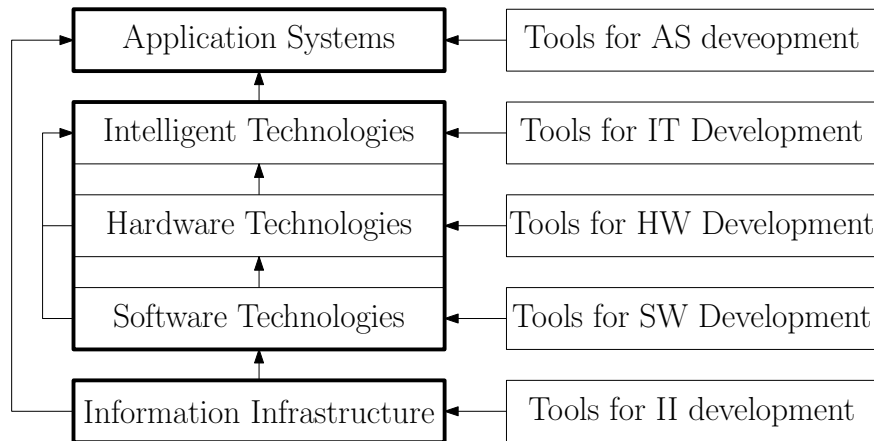
(*) Some tools might have applied intelligent technologies.

(**) The middle block is the intelligent infrastructure.

Figure 3: Intelligence infrastructure includes the (1) intelligent technologies, the (2) hardware and (3) software technologies specially developed to support the intelligent technologies. One should be noted that some development tools might have applied intelligent technologies.

Today, we have a lot more emerging technologies available in the *information infrastructure*. They include the personal area network (PAN), high speed wireless communication, Internet of Things (IoT), Internet of Vehicles (IoV), global positioning systems (GPS), mobile devices (smart phones, pads, watches and wearable devices), virtual reality (VR) headsets, augmented reality (AR) headsets like Microsoft Hololen, 5G communication technologies, cloud platforms and others.

The services delivered on top of this information infrastructure, like Google Map and Facebook, would definitely facilitate the development of intelligent services to be added to the *intelligence infrastructure*. Intelligent systems development could be even faster then ever.

2.4   Emerging technology management

As emerging technology is simply a subset of 'technology', emerging technology management could simply be defined in the same way as technology management, by replacing technology to emerging technology.

Emerging technology management is a management process covering (1) the management of the usage of emerging technologies with access right granted for work, (2) the management of the development of a new technology and (3) the management of the access right of the new technology.

3   Learn/Understand Emerging Technology

To understand a technology, it could be accomplished from two approaches. First, one could start from its (technical) working principle and then infer the potential applications of such technology. This approach is a tough approach as the learners need to have sufficient mathematical knowledge to understand the technical background of those 'technologies'. The second approach is a bit easier, one could start from an application and then learn from the application what technologies have been applied. The learners have only to learn from the applications why those technologies are applied and thus to learn the application scopes of each of these technologies.

From the perspective of the second approach – starting from an application to learn the technologies being used for supporting such an application, one should be clear that applications are developed for different group of users and different industries.

1. Technologies for personal applications. Table 1 lists a number of emerging technologies being used in John Sum daily life and work.

2. Technologies for business administration. Table 2 lists a number of emerging technologies which have been used to facilitate business administration.

3. Technologies for business operations. Selection of technologies to facilitate an operation is a tough decision problem as it is adhere to the operation design. Selection of technologies is depended on the operation design. On the other hand, the design of an operation is also depended on the technologies available.

4. Technologies for industrial applications. Similar to business operations, selection of technologies to aid an industrial application is a tough decision problem. Selection of technologies is depended on the operation design for an industrial application. On the other hand, the design of an operation is also depended on the technologies available.

5. Technologies for car manufacturing. Definitely, robotic technology is a set of technologies being used. Again, selection of other technologies to aid car manufacturing is a tough decision problem. Selection of technologies is depended on the operation design for a car manufacturing. On the other hand, the design of an operation is also depended on the technologies available.

6. Technologies for health care.

7. Technologies for information and communication.

8. Technologies for logistics and transportation.

9. Technologies for education.

10. Technologies for aerospace industry.

11. Technologies for financial industry.

12. Technologies for smart home.

13. Technologies for smart cities.

14. Technologies for homeland security.

15. Technologies for research. Some of them have been depicted in Table 1.

For each of the above categories, how many technologies you can name of and how many technologies you know how to use? How many of them their working principles you really understand?

4 Workflow Management

In Table 2, information system is able to facilitate workflow management. Note that this system is basically a job completion administration system. In simple words, it is a system for the workers to report his/her job completion. There is no any advance technology applied. Here, let me explain what is it about.

4.1 Project budget request

Imagine that a team in a department would like to request for a budget for a specialized project, see Figure 4. The team will first need to file a budget request form and pass it to get approval from its department manager. Once the department manager has signed to approve the request, the form will then be passed to the financial department for budget availability. If it is available, the request form will be passed to the chief financial officer (CFO) for the final approval. The request form is then passed back to the team confirming the budget approval. A budget approval form is then passed to the financial department to reserve the budget for the team.

The above flow of the budget request from a department team to the CFO is so-called the workflow for budget request. Clearly, this workflow can definitely be facilitated by the use of an information system. The flow of the budget request form is made electronically and each approval step can be done online.

4.2 Operation design

Clearly, many workflow management systems have been developed for *order placement and fulfillment* and *manufacturing*. A key benefit of these systems is simply to facilitate the workers to report their completion of their works online. The managers are then able to online monitor the progresses via the workflow management systems regarding the progresses of the operations. One should be noted that a success factor for the use a workflow management system is not on the technologies applied in the system. Instead, it is on the design of the workflow, i.ee. the operation design.

Table 1: Personal (John Sum) Use of Emerging Technologies.

Technology/Software	Daily Live	Daily Work
Line	Text Message	–
WhatsApp	Test Message	–
Siri	Text Message	–
Amazon Echo	Smart Home	–
NCHU Webmail	–	Email
Gmail	–	Email
Yahoo! Mail	Email	Email
Gate Barrier	Plate Recognition	Plate Recognition
Navigation System	Drive Direction	Drive Direction
Google Map	Route to Destination	Route to Destination
Bus Schedule App	Bus Schedule	Bus Schedule
Hotspot	Notebook WiFi Access	Notebook WiFi Access
Spell Check	–	Editing
Word Suggestion	–	Editing
Spell Correction	–	Editing
Grammar Check	–	Editing
Google Search	–	Use of English
	–	Acquire Knowledge
Google Translate	–	Use of English
	–	Chinese Abstract
Wikipedia	–	Use of English
	–	Acquire Knowledge
ChatGPT	–	Acquire Knowledge
	–	Paraphrasing
	–	Research
	Chat	–
Google Bard	–	Acquire Knowledge
	–	Paraphrasing
	–	Research
	Chat	–
Gmail	–	Teaching
TeamViewer	–	Research
Computer	–	Research
Matlab	–	Research
DevC	–	Teaching
Python	–	Teaching
	–	Research
MikTex	–	Editing
WinEdit	–	Editing
Texstudio	–	Editing
IPE	–	Diagram drawing

Table 2: Emerging Technologies for Business Administration.

| Technology/Software	Business administration
Line	Unofficial group communication
WhatsApp	Unofficial group communication
Siri	Voice-to-Text
Cell phone	Official/Personal communication
Webmail (Official)	Official communication
Gmail or Yahoo!Mail	Personal communication
MS WORD spell check	Reporting & documentation
MS WORD word suggestion	Reporting & documentation
MS WORD spell correction	Reporting & documentation
MS WORD grammar check	Reporting & documentation
MS PowerPoint	Presentation slide preparation
Google Search	Use of English for documentation
Google Translate	Use of English for documentation
ChatGPT or Google Bard	Paraphrasing
Google Meet	Virtual meeting
Database management system	Data management
Information system	Workflow management
	Document management
Computer	Work
Projector	Reporting
Network communication	Information infrastructure
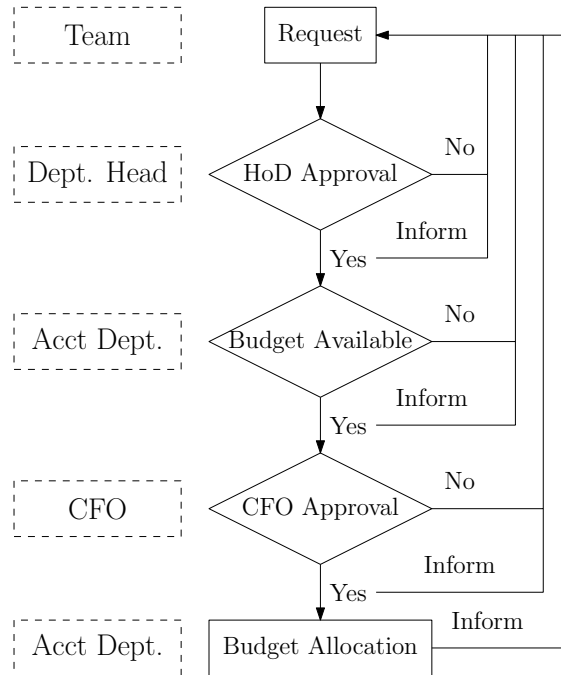
Figure 4: The workflow of a project budget request process. In each stage of decision, the corresponding party has to inform the department team for the decision so that the team is able to know the progress of its request.

5 Emerging technologies for EC

For any EC firm, her profit can only be made after a transaction has been completed. A transaction starts at the moment when a customer has placed an order and ends up at the moment when the customer has got the items purchased.

5.1 Order placement and payment

Owing to accomplish an order placement, a website has to be ready for the customer to access and place an order. Besides, the website is needed to provide a few common payment methods for the customer to settle the payment.

In the following, the steps in which a customer needs to go through in an order placement will be listed. To start with, we need the following assumptions on moment when the customer is in order placement process.

- The customer has already invoked a browser in his/her computer and entered the URL of the dotcom on the address bar of the browser.

- The customer's computer and the dotcom website have already been connected to the Internet.

- The customer has already registered a member account on the dotcom website.

- All the necessary information for the customers have been available on the website.

- Both the customer and the firm have their bank accounts for the payment transfer.

- The website has a module interacting with at least one electronic transaction system (ETS) provided by a financial institute.

- It is assumed that the customer will not cancel the order after the order has been successfully placed.

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----------------------------------------------------------------------
Order Placement Process (Between the customer and the website)
----------------------------------------------------------------------

Step 1: (Customer login.)
        1.1: Customer enters via the browser an account and its password.
        1.2: The account name and the password are sent to the website.
Step 2: 2.1: The website checks if the password is correct.
             If it is correct, the next step goes to Step 2.2.1.
             If it is incorrect, the next step goes to Step 2.2.2.
        2.2.1: The website returns to the customer the default webpage
              for online shopping. The next step goes to Step 3.
        2.2.2: The website returns to the customer an error page.
              The next step goes to Step 1.
Step 3: 3.1: Customer browses the product catalogue and/or search
             for the products of interest.
        3.2: Customer selects the items to be purchased.
        3.3: Customer submits the order.
Step 4: Website returns the order information for confirmation.
Step 5: Customer confirms the order to the website.
Step 6: Website returns to the customer the payment/delivery page.
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Step 7: 7.1: Customer selects a payment method and a delivery method.
        7.2: Customer enters the credit card information for payment.
        7.3.1: Website acts on behalf of the customer to request the
               ETS for payment transfer.
        7.3.2: The ETS transfers the amount from the customer's
               bank account to the firm's bank account.
        7.3.3: Once the payment has been received, the firm's bank
               informs the accounting information system of the firm
               for the settlement.
        7.3.4: The bank of the customer informs the customer about the
               payment transfer.
Step 8: 8.1: Website interacts with an ETS to confirm the settlement.
        8.2: Website returns the receipt in a form of webpage.
Step 9: 9.1: Website saves the order information in the DBMS.
        9.2: Website informs the logistic center for order fulfillment.
Step 10: Customer logs out the account.


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The above steps only show a rough outline of an order placement process. Many technical details have been omitted.

- The method how the website informs the logistic center for the new order has not been specified.

- The technical detail on the graphical design of those web pages has not been elucidated.

- The method how the website interacts with an ETS to confirm the settlement has not been mentioned.

- Dependent on the firm policy, the order information might have to be saved in multiple DB management systems, such as the accounting information system and the customer relationship management system. For the sake of presentation, this part has not been explored here.

Note that the above order placement process is applicable to both the conditions that (1) the customer accesses the website via a computer and (2) the customer accesses the website via a cell phone.

5.2   Order fulfillment

Once a customer has successfully placed an order, the order information will then be saved in some DB management systems. Clearly, the order information must be stored in an information system in the logistic center. Before the detail steps in the order fulfillment process are depicted, a few assumptions have to be made.

- An information system has been developed and connected to the website for a worker in the logistic center to get the details of the new orders.

- The purchased items are available in the logistic center for packaging and delivery.

- A user account in the logistic center information system (LCIS) has been logged in and no worker is allowed to log out the account.

- The 3PL information system (3PL IS) has already been connected to the Internet. Moreover, the 3PL IS has been developed to interact with the website.

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------------------------------------------------------------------------
Order Fulfillment Process
------------------------------------------------------------------------
(LC worker: logistic center worker.)
(LCIS: Logistic center information system.)
(3PL: Third party logistic.)
(3PL IS: Third party logistic information system.)

Step 1: 1.1: LC worker gets a new order information from the LCIS.
        1.2: LC worker prints all the adhesive labels for the new order.
        1.3: LC worker taps the labels on a parcel box.
Step 2: 2.1: LC worker collects the ordered items.
        2.2: LC worker packs the items in a parcel box and seals the box.
        2.3: LC worker puts the parcel box in the area for delivery.
        2.4: LC worker confirms via the LCIS for the job completion.
Step 3: 3.1: LCIS informs the 3PL IS notifying for the new delivery.
        3.2: 3PL IS informs a 3PL worker the new delivery.
Step 4: 4.1: 3PL worker collects the parcel box.
        4.2: 3PL worker confirms via the 3PL IS for the box collection.
Step 5: 3PL worker delivers the parcel box to the customer.
Step 6: 6.1: Customer confirms via the 3PL IS the receiving of the parcel.
        6.2: 3PL IS updates the status of the delivery as completion.
Step 7: 3PL IS informs the website for the completion of the order.


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Similar to the order placement process, the above steps only show a rough outline of an order placement process. Many technical details have been omitted. To accomplish the completion of the order placement and order fulfillment processes, a number of systems have to be working together. Figure 5 shows the software and systems to be involved in these processes.

5.3 Replenishment

A possible design for the replenishment process is shown in Figure 8. In this design, a number of assumptions have to be made.

- The replenishment process is initiated by the logistic center information system (LCIS). A program in the LCIS has been scheduled to be running at 22:00 each day.

- A worker in the EC logistic center will log in the LCIS every working day for the list of items with low stock level.

- A worker in the factory will log in the factory information system every working day for the list of replenished items and the list of non-defective items being delivered to the EC firm.

Figure 9 lists the detail steps to be accomplished in the operations design as shown in Figure 8.

5.4 Technology management

From the above operation designs for online shopping, you should be aware that many technologies have to be applied to make a transaction successful. What technologies should be applied? How many of them you can identify? Here, at least three types of technologies have to be applied.

- Technologies for building the online shopping site, i.e. information flow.
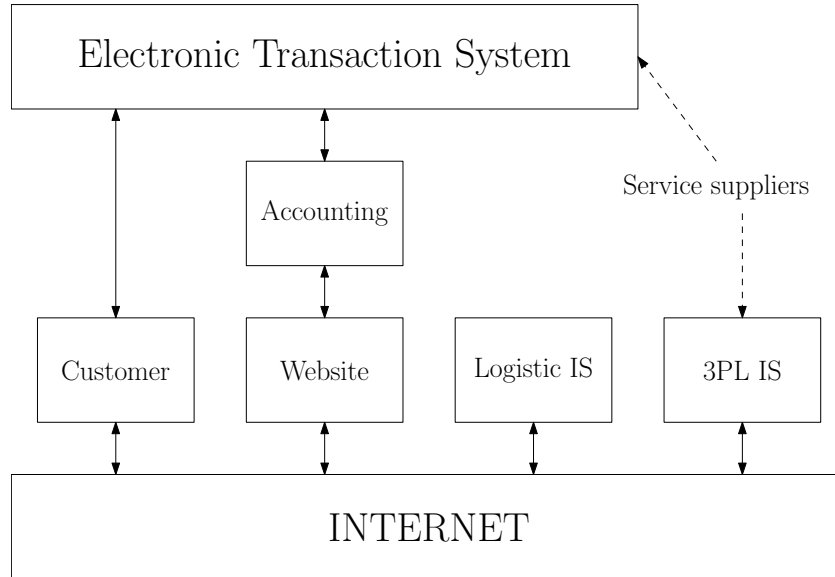
Figure 5: A schematic diagram for the software and systems being involved in the order placement and order fulfillment processes. Each arrow corresponds to the direction of information flow. In this diagram, the flow of the physical product has been omitted.

- Technologies for cash flow.

- Technologies for logistic, i.e. product flow.

A a mater of fact, selection of the emerging technologies for implementing such operations is a key problem to any technology manager.

References

[1] M. I. Jordan, "Artificial Intelligence – The Revolution Hasn't Happened Yet," *Harvard Data Science Review*, vol. 1, no. 1, July 2019. [Online]. Available: https://hdsr.mitpress.mit.edu/pub/wot7mkc1

Electronic Transaction System
(Banking System)

Accounting

(8.1)

Service suppliers

Customer

(1, 3, 5, 7)

Website
(2, 4, 6)
(8.1, 8.2, 9.1, 9.2)

Logistic IS

(9.1)

3PL IS

INTERNET

(1)

(2)

(3)

Order Placement Process
Sequence Diagram

(4)

Time

(5)

(6)

ACCT

ETS

(7)

(8.1)

(8.2)

(10)

(9)
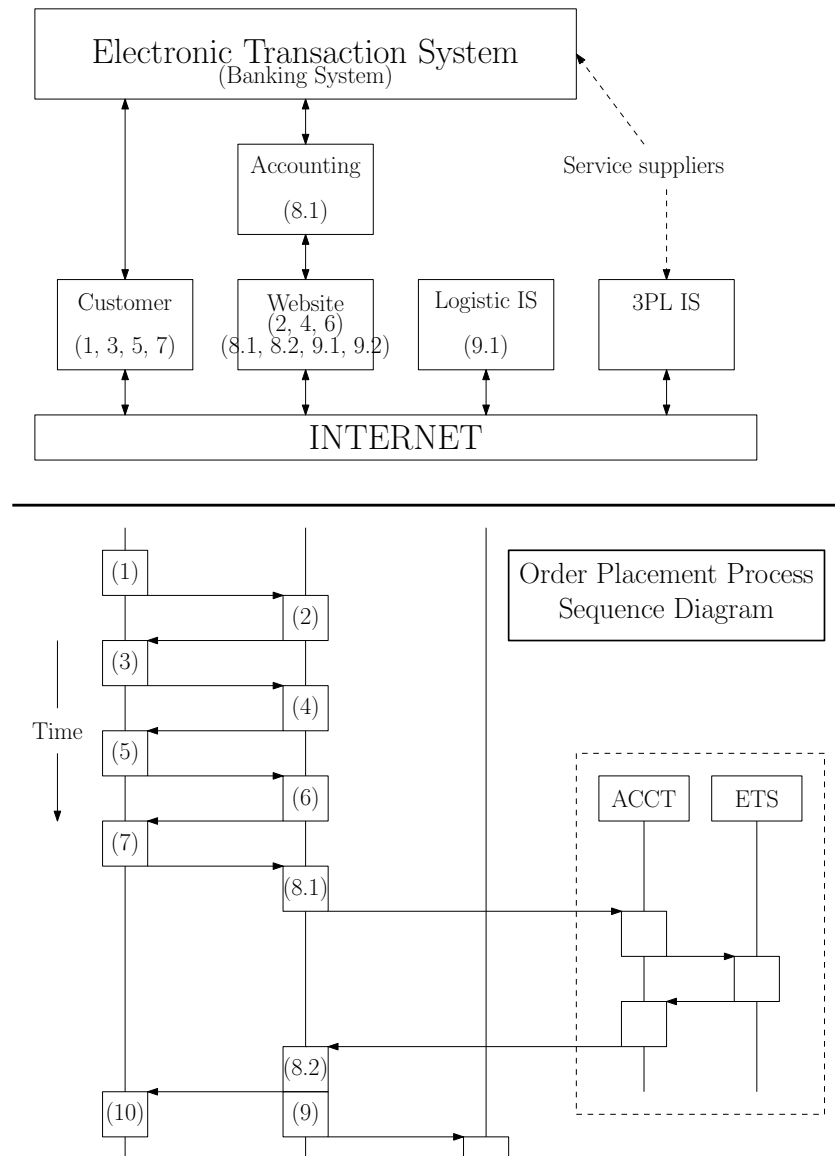
Figure 6: Sequence diagram of the order placement process.

15

Electronic Transaction System
(Banking System)

Accounting

Service suppliers

Customer

(6)

Website

(4, 7)

Logistic IS

(3)

3PL IS

(3, 4, 7)

INTERNET

Customer | Worker | LCIS | 3PL IS | Deliverer | Website

(1)

(2)

(3)

(3)

Order Fulfillment Process
Sequence Diagram

(4)

(4)

(4)

(5)

(6)

(7)

(7)
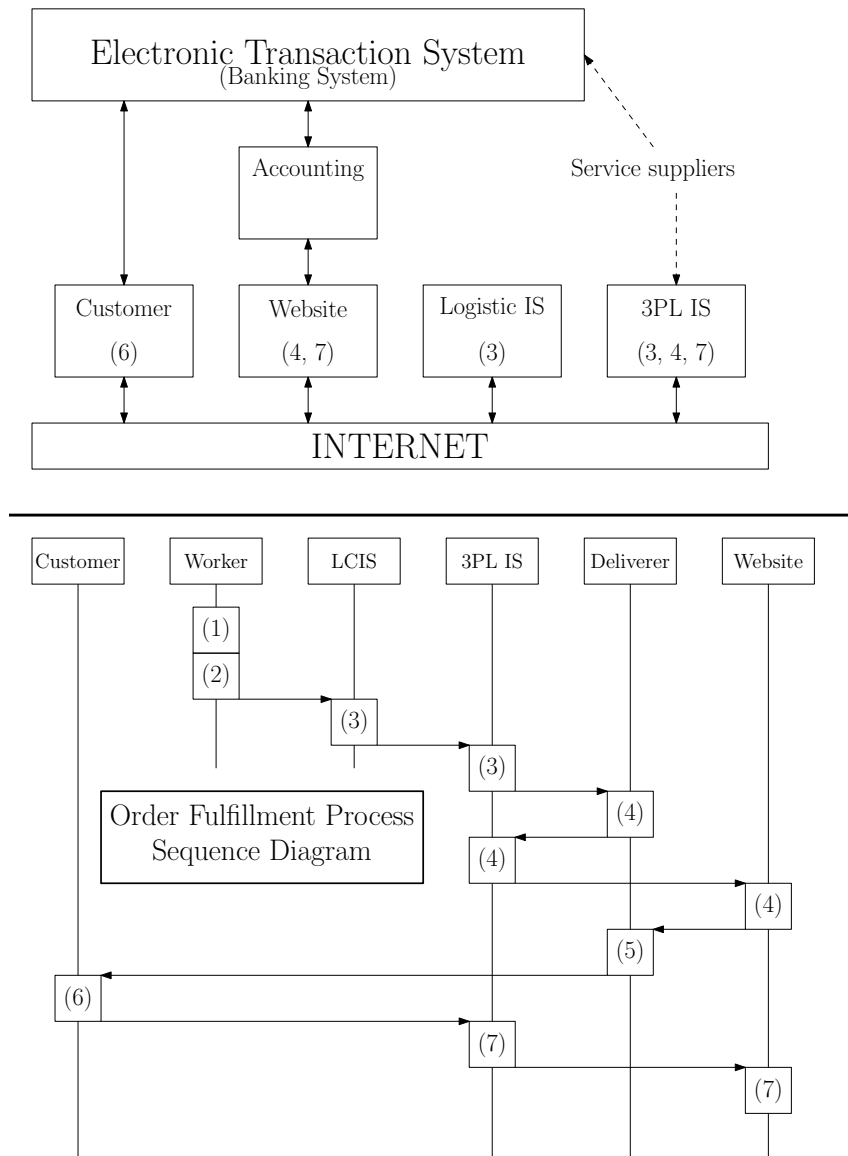
Figure 7: Sequence diagram of the order fulfillment process.
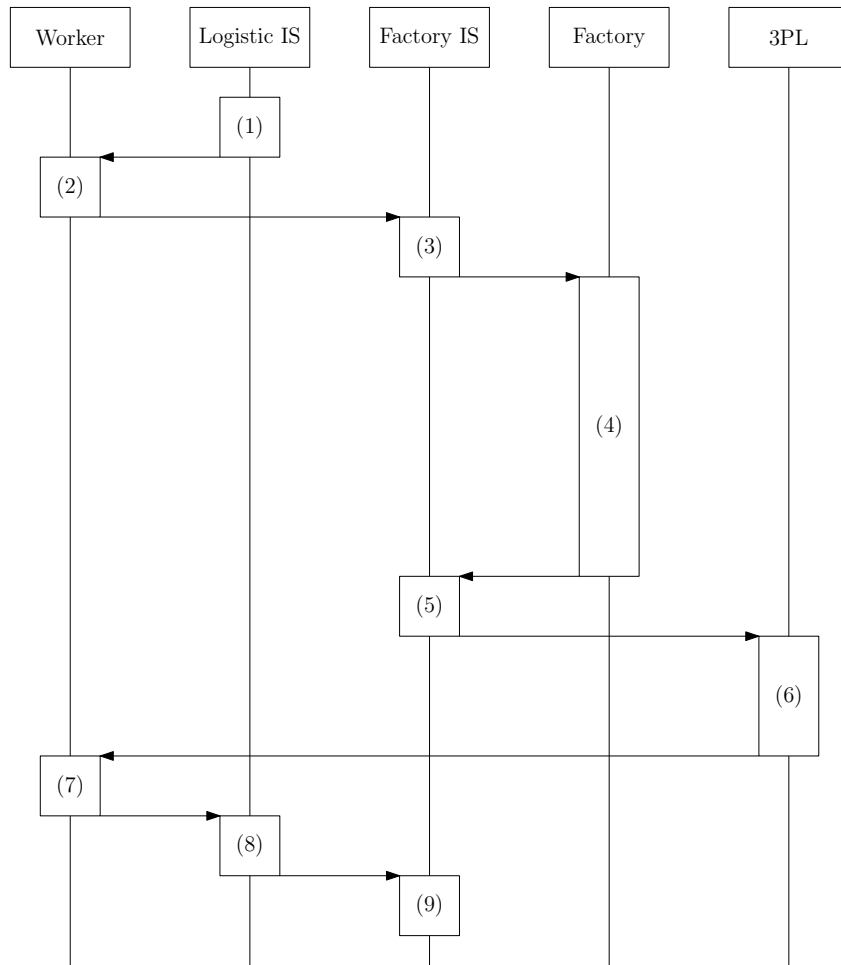
Figure 8: Replenishment process.

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Replenishment Process
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Step 1: 1.1: LCIS checks from the DBMS the stock level of each item for sale.
        1.2: LCIS compiles a list of items whose stock levels are low.
Step 2: 2.1: A worker check the list of items with low stock levels.
        2.2: A worker decides a list items to be replenished.
        2.3: The list of items is sent to the FIS.
Step 3: 3.1: The FIS updates the request in the DBMS.
        3.2: The FIS informs the factory for the production.
Step 4: 4.1: Factory produces the requested replenishment.
        4.2: A worker in the factory updates the production status to the FIS.
Step 5: The FIS informs a 3PL for delivery.
Step 6: 6.1: The 3PL arrives the factory and collects the items.
        6.2: The 3PL delivers the items to the logistic center of the EC firm.
Step 7: 7.1: A worker in the EC logistic center checks the items for defective.
        7.2: A worker puts the item to its shelf.
Step 8: 8.1: If an item is not defective, its bar code will be scanned.
             That is to say, its information is thus entered in the LCIS.
        8.2: The LCIS informs the FIS for those non-defective items.
Step 9: The FIS updates its DBMS for those non-defective items.
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Figure 9: List of the steps for the operational design as shown in Figure 8.