

# **Applying Artificial Intelligence to enhance purchasing performance**

**A case study of company B**

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<p>Abstract</p> <p>Purchasing plays a critical and decisive role, providing strategic directions for firm's success in finance, commerce, production and operation. In this fast pacing developing world, speed, productivity, real time and best practices are what any industry is striving for, and information technology is one of the most appropriate adoptions.</p> <p>The objective of the study was to provide large scale companies with an idea to optimize their future operations, of which purchasing is a target, by concentrating on the development of information technology. Artificial Intelligence (AI) has been a breakout technology in many industrial fields and other business sectors, so it was an aim for the study of the success in enhancing purchasing performance, which has not received many scholar research yet.</p> <p>The study was implemented by utilising qualitative research method with the data collection methods of observation, chronicle reports, interview and literature review. The data was analysed critically to give answers to the stated research questions that led to the research's outcome. The purchasing process and current information technology systems were looked into so as to understand the case company's Purchasing Department's operation. Investigating the obstacles that occurred in daily purchasing activities and potential challenges the department may face in the future played an important role in coming up with an appropriate solution and navigating the areas that can benefit most from the solution. The challenges of the solution were also reviewed.</p> <p>As a result, Artificial Intelligence (AI) was proved to be a suitable and potential solution for saving the costs of purchasing and increasing its productivity. AI was also recognised to be aligned with the case company's and the world's development trend.</p>		
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## Terminology

Request for information (RFI): the invitation from buyer to supplier to provide their company's information

Request for quotations (RFQ): the supplier is asked to submit the quotations for the demand product or service

Comparison of quotations (CoQ): quotations from different suppliers for a certain product or service is confronted

Purchase requisition (PR): a request from end user to implement the purchase

Purchase order (PO): a request sent to supplier for purchasing the product or service

Systems Applications and Products (SAP): an enterprise resource planning (ERP) software that centralizes data throughout a business so that one department can have a real-time access to others' information, creating streamline activities within a firm

# 1 Introduction

## 1.1 Background of the study

In today's rapidly developing era, not only small businesses are striving for evolving and asserting themselves in the marketplace, but big corporates are also under pressure of moving forward to stay competitive. It is said that being innovative is an inevitable part of establishing a successfully sustainable business, so there is no chance for resting on laurels. Moreover, under great influenced circumstances, for example Corona pandemic, which has lasted for more than a year now and has affected a variety of industries, seeking for concrete solutions to be ready for any bad situation is a crucial action that every companies need to take.

In Vietnam, purchasing is still underestimated due to its name reflecting a regular shopping activity and so it is regarded as an added function for a company, supporting other more important departments in their daily jobs. The reality is on the contrary, purchasing plays a critical and decisive role, providing strategic directions for firm's success in finance, commerce, production and operation. Fortunately, a majority of big corporates in Vietnam have realized the importance of Purchasing Department and are constantly looking for ways to improve the department's performance. Back office jobs, including purchasing, are famous for paperwork and manual work; however, those days are far behind. In this fast pacing developing world, speed, productivity, real time and best practices are what any industry is striving for, and information technology is one of the most appropriate adoptions.

Artificial Intelligence (AI) is an advanced aspect of information technology and its benefits are undeniable. AI is said to be only efficient in science and engineering industries, but the fact has proved that it can be also utilized for business activities, a clearest example is the sign of Chatbot popping up whenever one visits a website, and it is not just limited to that. Even though AI requires costly initial investigation, Forbes anticipated that by 2020, firms that apply AI and/or its subsets – machine learning, will take an advantage of \$1.2 trillion per year more than the ones who abandon this concept.

(Manandhar 2019.). Due to which, there is no reason to oppose the supportive relationship between AI and purchasing.

## 1.2 Introduction to case company

This research is conducted for company B in Vietnam (company B), a representative branch of R GmbH. R GmbH is one of the leading multinational engineering and technology companies with headquarter in Stuttgart, Germany, founded in 1886. Since 2007, in Vietnam, B has established a main office in the centre of Ho Chi Minh city, a push belts for continuously variable transmissions (CVT) production plant in Dong Nai province, a software and engineering R&D centre in Ho Chi Minh city, an automotive R&D centre focusing on mobility solutions in Ho Chi Minh city and branch offices in Da Nang and Ha Noi. Mobility, Building Technologies, Drive and Control Technology and Power Tools are the focal businesses of company B. The Purchasing Department is located at the main office, which not only buys for company B in Vietnam but also supports purchasing activities in Malaysia, Indonesia, Thailand, Singapore and Philippines branches.

After her six-month internship at B, the author was eager to contribute to the development of the company and she would like to start with the area in which her daily tasks had taken place, Purchasing Department. The ideas were shared and reviewed with experts from the department and the author received interest, encouragement and promising support from them.

## 1.3 Research objectives and research questions

Aligning with the mentioned facts in “Background of the study” part, this research is developed with the aim of providing large scale companies with an idea to optimize their future operations. More specifically, the research is limited to purchasing field when its target is to bring a fresh perspective to contribute to the development of Purchasing Department in the author’s former intern place, and it is hoped to be applied in other company’s branches and even in any different businesses.

Although AI is not a new phenomenon in this day and age when it is easy to point out its application in education, manufacturing, warehousing, marketing and sales, this concept still remains uncovered in purchasing. In academic world, there are not many research related to applying AI to purchasing. Therefore, this thesis may generate a new hypothesis and act as a reference for future studies of other researchers.

Additionally, this thesis opens a good opportunity for the author to gain a deep insight about purchasing and AI (where machine learning and data analysis are the relating parts), which are of the author's interest and future career plan.

To reach the mentioned objectives, the following research questions need to be taken into consideration:

- **What is the purchasing process implemented by Purchasing Department of company B? What kind of products and services is company B buying?**

Before evaluating a process and bringing up ideas to improve it, the process itself must be clarified. The author's intention is first to study the purchasing process in company B, which can be done through own observation during her time working there and through reference from senior buyers in the department. Following by that, the types of products and services purchased are exploited.

- **What are the challenges that Purchasing Department of company B is facing in its daily activities?**

The answer to the first question is a leverage for finding the answer to this second one. The aim of the author is to detect the challenges that hinders purchasing experts from doing their job effectively.

- **How can AI be applied to get rid of the purchasing inefficiencies? What opportunities does this solution bring and what are the inadequacies?**

This is the most important and practical question for the thesis. Based on the findings from question 1 and 2, the author will look into which areas in purchasing that AI is applicable and how AI can impact purchasing. Moreover, the

challenges in adopting AI into purchasing will also be analysed to give a comprehensive view about it.

The mentioned research questions are aligned with the research framework which is illustrated as follow:



Figure 1 Research framework

#### 1.4 Research methods

In order to conduct a research, benefit from it and achieve the objectives, researcher has to choose an appropriate research method(s). To do that, one must understand the methods' definitions, the circumstances in which they are used and the distinctness between them. Typically, there are two types of research methods: qualitative research and quantitative research. After considering the research situation and resources, the author decided to utilize qualitative research method and the reasons for her selection will be indicated afterwards in this chapter. Before getting deeply into qualitative and quantitative terms, the following approaches need to be revealed.

##### DEDUCTIVE AND INDUCTIVE APPROACHES

According to Greener and Martelli (2020, 18), **deductive approach** starts with theory, from that, hypotheses which connect with the target of the research are built and theory testing is thence implemented. The flow of deductive reasoning is from general to specific. In deduction, as theory is the fundamental to reach the inference of a case, preceding knowledge about the theory-based phenomenon is extremely important (Kananen 2011, 40). Deduction process requires amassing proof, posing the correct inquiries, planning and afterward assessing a hypothesis, and arriving at a resolution (Smith 2012).

On the contrary, going from specific to general is the way of **induction reasoning**, in other words, making generalizations from some specific cases. The generalizations or theories are achieved by collecting investigations. (Kananen 2011, 40.). Greener and Martelli (2020, 18) indicated that to develop a reliable and widely applicable theory from inductive reasoning, it requires thorough observations of the circumstance and consideration about conceivable causal connections in that circumstance.

## QUANTITATIVE METHOD

Quantitative research is related with deductive approach, so theory and phenomenon's understanding are the foremost requirements. Quantitative research includes numerical data collection and mathematical models are the typical tool for data analysis. (Williams 2007, 66.). Kananen (2011) equated the quantitative research process with a train, which goes through stages following strict statistical rules. Due to which, with this method, if defects appear during the research process, the whole process has to be done from scratch. (72-73.)

Descriptive, experimental and causal comparative are the three distributions of quantitative research (Leedy & Ormrod 2001). **Descriptive research** is an approach where the characteristics of the phenomenon is determined at its current state by observing the correspondence between two or more phenomena. Meanwhile, in **experimental research**, the researcher interferes the sample and then quantifies the results of the treatment. In **causal comparative research**, the researcher inspects the effects that dependent variables have on independent variables and hence it allows understanding of the interrelation between variables. (Williams 2007, 66.).

There are various research methods supporting quantitative research such as correlational, developmental design, observational studies, and survey research, which are most applicable for descriptive research, but may likewise be utilized to some extent with other two classifications (Williams 2007, 67). As the meaning lies in the name, **correlational research** method pays attention to determine how two or more variables distinguish through a statistical test and from that, researcher discovers whether there is a relationship between them (Williams 2007, 67; Creswell 2002). Studying the

chronological change of variables in a sample is the method of **developmental design**. In this type of method, while cross-sectional study is implemented by correlating and contrasting two study groups having equal criterion, the longitudinal study allows understanding of a phenomena applying to a group over time. (Leedy & Ormrod 2001.). In **observational study**, data is obtained by observing a specific facet of human behaviour in an objective way. A similar but more interactive method is **survey research**, where researcher collects data from representors of a population who have answered the given questionnaires. This method is commonly used, and it requires large samples. (Williams 2007, 67.).

## QUALITATIVE METHOD

If quantitative research method is about drawing conclusions on some cases from a theory, qualitative research method is about observing characteristics of some cases to form theories, which is the way of inductive reasoning. This research method is utilized when there is no pre-understanding about the new phenomenon, and the “what” question has to be made to characterize it. (Kananen 2011, 37.). Trochim and Donnelly (2008) suggested the circumstances to conduct qualitative research as below:

- The phenomenon is uncharted
- The phenomenon needs profound comprehension
- Establishing new theories and hypotheses
- Incorporating different research methods
- Securing an exact depiction of the phenomenon

Phenomenological, content analysis, ethnography, grounded theory and case studies are the most suggested methods to generate qualitative research.

In **phenomenological study**, the viewpoint of participants about a situation is a focus (Leedy & Ormrod 2001). The study begins with identifying research questions which associate with the objectives of the research, then interviewing the people who have experiences in the event, analysing the collected data which illustrates people’s common awareness of their experiences and finally writing a report (Creswell 1998).

**Content analysis study** aims to observe the content in books, newspapers, films and other forms that human uses to communicate, and from that, researcher pinpoints patterns, themes and biases. The procedure of collecting the data contains two steps: the first step is investigating the materials and establishing a frequency table in which the characteristics are shown, the second step is adopting a quantitative format report that releases the outcome of a statistical analysis. (Williams 2007, 69.).

In **ethnography study**, researcher looks at a group that has a similar culture and figures out the transformation of that culture through time (Creswell, 2003.). Williams (2007, 67) recognized a weakness of this method was that the result obtained might not be applicable for other theories, in other words, the generalization degree was low. This method of study requires the researcher to familiarize with individuals of the group and their daily practices by visiting their workplace, observing their behaviour and building trust among them (Creswell 1998). Then the interviews can be executed.

In **grounded theory study**, researcher endeavours to determine a general theory of a cycle, activity or collaboration grounded in the perspectives of the participants (Creswell 2003). The collected data that is used to develop into a theory must be from the spot where participants interview, documentaries review and on-site inspection take place, not from literature (Leedy & Ormrod 2001).

**Case study** is a method that requires deep learning about a program, process, event, activity or individual, to help enhance the understanding of the situation (Creswell 2003; Leedy & Ormrod 2001). Case study involves data collecting from interviews, observations, chronicled records or reports and varying media materials; and lesson learned in the end of the report (Williams 2007, 67).

This thesis is targeting at nominating AI – an optimal solution that should be suitable for company B's Purchasing Department's current situation, which is therefore a rather new phenomenon for the case company. The author does not know what effects it brings about yet to the company, she has to find out the answers for that "what" question. Moreover, because of company B's strict regulation relating to data security creates a limitation for gathering a massive numerical resource from this study group,

the thesis does not deal with number and hypothesis testing. Therefore, quantitative method is not related to this thesis while qualitative is the most appropriate one. To conduct the qualitative research, case study is applied as a real case company is to be studied for the application of the proposed solution. The detailed methodology will be described in chapter 3.

## **2 Literature review**

### **2.1 Purchasing**

#### **2.1.1 Definition**

It is said by Lysons and Farrington (2006, 6) that purchasing is a subdivision of procurement because procurement means acquiring goods or services in the form of buying, leasing, borrowing and even taking over or looting while purchasing means trading money or corresponding payment for goods or services. Or there is another argument that procurement comprises of the activities related to sourcing, negotiating and choosing the goods or services, and purchasing only deals with placing the orders (Difference Between International Purchasing and Global Sourcing 2018). However, usually, the terms “purchasing” and “procurement” are used compatibly to indicate an activity of obtaining goods or services according to demands. Purchasing is prototypically defined as buying materials in a way that the right quality, right quantity, right source, right delivery place, right time and right price are secured (ibid.). Generally, Van Weele (2010, 3) described purchasing as the administration of the organization's outside assets so that the provision of all merchandises, goods, services, capacities and information which are important for running, keeping up and dealing with the organization's primary and support activities is ensured under the most appropriate conditions.

### 2.1.2 Purchasing process

The procedure to purchase goods or services whenever required by somebody in the organization consists of all steps from defining the requirements to paying for the received items; this is also regarded as a procure to pay cycle (Monczka, Handfield, Giunipero, & Patterson 2009, 42). These steps are illustrated in the following figure.



Figure 2 Purchasing process (adapted from Monczka, Handfield, Giunipero, & Patterson (2009, 43)).

#### **FORECAST AND PLAN REQUIREMENT**

It is impossible to take any actions for the purchase of good or service if its specifications are indeterminate. In this stage, the purchaser needs to set up a forecast of what is going to be bought, how many of it is needed, at what date and time it shall be obtained, which can be discussed alongside with end users. However, the forecast is not always optimal or even not available at all, these are the cases when the end users are not clear yet about the needed quantity or receiving time, or the demand is sudden, unplanned and is expected to be procured immediately. Under such circumstances, the purchaser has to negotiate with suppliers in a reasonable way. (ibid., 44-46.)

## **NEED CLARIFICATION: REQUISITIONING**

The internal customers express their needed goods or services' stipulation through a platform called a purchase requisition. The most common format of the purchase requisition includes:

- Good or service characteristics
- Quantity and date
- Predicted or allowed budget
- Operating account that will be used to pay to supplier
- Requisition date
- Date required
- Accredited signature. (ibid., 46-53.)

## **SUPPLIER IDENTIFICATION AND SELECTION**

Once the requirements and specifications are made clear, either of these two situations will occur: (1) There is a pre-existed vendor that is having contractual relationship with the company who can accomplish the need. (2) The supplier is not yet identified, or the new supplier is nominated by end users. The first case is an ease for the purchaser because the supplier has already been through the sourcing and evaluation process, also has proved themselves as being qualified and trustful through previous performance. However, for the second case, it is more complicated as the purchaser has to search for suppliers and select one that is suitable. (ibid., 54-58.)

Supplier selection is one of the most important and challenging steps since any mistakes made will result to damaged and long-lasting purchasing cycle. Two popular methods assisting final supplier selection in case of no existing preferred supplier are competitive bidding and negotiation. Competitive bidding means the company asks for suppliers' bids by sending them a request for quotation (RFQ) and once the suppliers quote their prices, often the supplier with the lowest price will be selected (ibid.). There is another kind of bidding called e-auction, which requires suppliers submit their bids continuously within a given time period on electronic platform for auction

(Hartley, Lane, & Hong 2004, 153). Meanwhile, negotiation's meaning lies on its name, it is usually done face to face (Monczka, Handfield, Giunipero, & Patterson 2009, 54-58).

### **APPROVAL, CONTRACT, AND PURCHASE ORDER PREPARATION**

Once the buying company manages to get a supplier, purchasing will approve the purchase of goods or services and then the purchase order is drafted in a careful manner. Usually, purchase order come along with an agreement on legal conditions, in most cases it is the contract. The purchase order shall at least include all crucial information describing the purchase such as quantity, specs, required quality, price, delivery method and date, receiving address, purchase order number and date of order. After both sides sign the purchase order, they have legally built a contractual relationship and a copy of this purchase order will be forwarded to accounting, requesting department and logistics department to hold them accountable for related activities. (ibid., 58-64.).

Beside this, a more detailed contract is obligated if the monetary value of the purchase is higher than a predetermined limit or if a concrete agreement is required to avoid any risks that could occur during the negotiation before every single purchase from the same supplier. It is called fixed-price contract. (ibid., 64-65.).

### **RECEIPT AND INSPECTION**

In this phase, the transmission of purchase requirements takes place, when orders/material releases are sent through mail or fax, or through electronical interface like Electronic Data Interchange. Then order follow-up is executed by purchaser or materials control group to keep tract of the purchase order status, balk late shipment and ensure an effective receiving process. (ibid., 65-67.).

## **INVOICE SETTLEMENT, PAYMENT, PERFORMANCE MEASUREMENT**

After supplier delivers the ordered goods or services, an authorization for payment is released by purchaser and payment to supplier is then carried out through accounts payable department in the buying firm. At this point, the purchasing cycle does not end yet. A last-but-not-least step of the procedure is supplier performance measurement, since it allows the buying organisation to evaluate the supplier and make better purchase decisions in the future, as well as helps the supplier realise what aspects need to be improved. (ibid., 67-68.).

### **2.1.3 Purchasing types**

#### **DIRECT MATERIALS AND INDIRECT MATERIALS**

There are two subsidiaries of purchasing that hold distinguished definitions and assignments but work together and are both important for the department: direct materials purchasing and indirect materials purchasing. **Direct materials** represent materials and services that contribute to a firm's value proposition (Van Weele 2010, 7), more specifically, they are employed in the assembling procedure and directly connected to the finished goods' production (Koskei, & Kagiri 2015, 29). This type of materials consists of raw materials, semi produced merchandise or half manufactures, parts (industrially called production materials or BOM-materials) (Van Weele 2010, 7). On the contrary, **indirect materials** identify with the materials that do not relate straightforwardly to the finished goods (Koskei, & Kagiri 2015, 29), and they carry a wide range of composition. Typically, they are classified into office equipment, insurances, traveling, computer software and hardware, cleaning materials and telecommunications (ibid.) but nowadays they comprise of additionally complicated goods and services like marketing, maintenance, repair and operation equipment, IT, facilities management materials (Lysons, & Farrington 2012).

## PURCHASING GOODS CLASSIFICATION

According to Monczka, Handfield, Giunipero, and Patterson (2009, 69), it is important to figure out what strategy is applied to what type of purchase to make make-or-buy decision, otherwise to select the most appropriate supplier. To do that, types of goods and services must be categorised. Eight suggested groups of materials with the characteristics of their purchases are described in the follow table:

Categories	Descriptions	Purchasing characteristics
<b>Raw materials</b>	<p>Go through no transformation process, are in their pure forms</p> <p>Example:</p> <ul style="list-style-type: none"> <li>• petroleum, coal, metals: iron, copper</li> <li>• agriculture: cotton, soybeans</li> </ul>	Purchase is done according to the demand in materials' grade
<b>Semifinished products and components</b>	<p>Tangibly exist in final product</p> <p>They are single-part number components, assemblies, sub-assemblies, systems, subsystems</p> <p>Example:</p> <ul style="list-style-type: none"> <li>• In automobile: car frames, seat assemblies, tires</li> </ul>	This type of materials influences end product's quality and cost => purchasing is pivotal, must work side by side with suppliers
<b>Finished products</b>	<p>Items that are procured to be resold to end customers</p> <p>Example:</p> <ul style="list-style-type: none"> <li>• In automobile: accessories for cars like alloy wheels and tires, navigation systems, stereo systems</li> </ul>	Purchaser must work side by side with supplier/producer of this type of material to make sure the end customers' requirements are met
<b>Maintenance, Repair, and Operating items (MRO)</b>	<p>Any items that are indirect materials, keeping business workflow</p> <p>They are cleaning supplies, spare machine parts, computer supplies, office supplies</p>	Purchase of MRO items is small-volume purchase and there are plenty of them

		Inventory must be kept track to know when to order new items
<b>Production support items</b>	<p>Packing and shipping materials for end product. They contribute direct support for production of end product</p> <p>Example: wrapping, pallets, box, containers</p>	<p>Sourcing must be done strategically and effectively</p> <p>Costs from these items must be minimized</p>
<b>Services</b>	<p>Are performed by external contractors</p> <p>Example: machine repair, lawn services, snow removal, consultants, or specialists to handle a distinct task</p>	Purchaser aims for long-term contracts
<b>Capital equipment</b>	<p>They are company's assets to be worked with over one year, even up to 30 years or more =&gt; are not purchased frequently</p> <p>Need rather huge investment</p> <p>Their value drops throughout their lifespan</p> <p>Can be easily impacted by economic situation</p> <p>Example:</p> <ul style="list-style-type: none"> <li>• Standard equipment, no specific requisition in terms of design: furniture, computers, printers</li> <li>• Equipment with specific design requirements: power-generating equipment, new manufacturing plants, specialized machinery</li> </ul>	<p>Supplier is almost impossible to be switched or equipment can rarely be thrown away due to discontent after their receiving</p> <p>Supplier must be capable of delivering services for the equipment during their usage time</p> <p>Supplier must be selected carefully because the relationship will last several years</p>
<b>Transportation and third-party purchasing</b>	<p>Transportation is a subset of service purchase. It is charged to transport the materials (alluded to <b>tariff</b>), transport provider is called logistics provider</p>	<p>Logistics provider is assessed and chosen in the same way as for other purchased materials. They are also expected to provide service for</p>

		warehousing, packaging, sometimes assembly
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Table 1 Materials categories and their purchasing characteristics (Adapted from Monczka et al. 2009, 70-73.)

#### 2.1.4 Benefits of purchasing

In the past, companies underestimated the role of purchasing or did not see purchasing as a function in the organizations at all. A research by Farmer in 1978 put a question on the contribution of purchasing to the performance of a business and the result came out to be that it did not prove its role in corporate strategy, instead, it was regarded more as an administrative function. Throughout this period, purchasing was seen as a passive position in an organization (Ammer 1974).

However, the view on purchasing role started to change. Carter and Narasimhan (1996) emphasized that purchasing was indeed a **strategic function** of a corporate. This was proved through realization of purchasing in terms of seven strategic factors: purchasing's importance, supplier interplay, other functions interaction level, management of job and personnel, supplier domination level, competitive focus and involvement of purchasing in organization. (24.).

Purchasing plays an important role in **ensuring quality of product and service** by thoroughly selecting an appropriate supplier with qualified supplies. This activity has a huge impact on the whole supply chain because if a problem occurs in the phase of raw material, it will consequently result in finished product, hence damage the company's reputation. (Monczka, Handfield, Giunipero, & Patterson 2009, 7.).

Purchasing is also a **coherency for engineers with supplier**, potentially helping enhance designs of product and process. Early engagement of supplier in the design phase leads to improvement recommendation opportunities, material cost cutback, material quality advancement and product development time decline. Here, purchasing demonstrate its ability to supplement added value to firm's process and escalate its competitiveness. (ibid., 7-8.).

Van Weele (2010) added three benefits of purchasing on an extremely important perspective that every company strives for as their main business target – return on net assets (RONA). Cost is one of the factors that receives most attention to be cut down on, in the meantime, the ratio between purchasing value and cost of goods sold (COGS) is 50%, which is truly significant. It was testified that 2% of purchasing saving would result in 9% increase of RONA. Purchasing strategies including for example suppliers amount reduction, product uniformity development, competitive bidding practice and alternative materials sourcing can give rise to the **decrease of direct materials costs**, consequently, affect RONA. Moreover, purchasing approaches in prolonging payment terms, employing just-in-time (JIT) program with suppliers, boosting suppliers' performance and preferring lease to buy of equipment can have a **positive impact on company's net working capital**. Purchaser also has a responsibility of awakening and taking advantage of supplier's expertise in the initial stage of product development process to add value for customer and bring back higher margin. This way is called raising the ability to **achieve better revenue**. (12-14.).

#### 2.1.5 International purchasing

International purchasing and global sourcing are often mistaken to have the same meaning. Their names lead people to understand that international purchasing is buying from other countries and global sourcing means looking for suppliers from other countries. Therefore, it gives a sense that they can be used interchangeably. However, in academic world, they are two distinguished terms. Trent and Monczka (2003, 29) described international purchasing as commercial exchange between a purchaser and a provider situated in various nations meanwhile global sourcing is said to involve incorporating company's worldwide locations with similar procedures, goods, technologies, designs and goods or services providers for their operational activities. Trent and Monczka concluded that international purchasing is more of a functional activity and global sourcing is a strategy, but in some cases, these terms can be merged, so they were suggested a generic name of "worldwide sourcing" (ibid., 29-31).

The reasons why a firm approaches worldwide sourcing are business condition transformation and needs or competitiveness aspects (Lysons, & Farrington 2006, 514). The detailed ideas for these are illustrated in the following figure.

Business condition transformation	Needs or competitiveness aspects
<ul style="list-style-type: none"> <li>• acute competition in global market</li> <li>• the urge to cut costs</li> <li>• flexible production need</li> <li>• diminished cycle time need</li> <li>• strict quality criteria</li> <li>• technology development</li> </ul>	<ul style="list-style-type: none"> <li>• material unavailability in domestic market</li> <li>• domestic providers' lack of ability</li> <li>• threat of scarcity or strikes of national resources</li> <li>• competitive prices, delivery and quality of sources abroad</li> <li>• countertrade and reciprocal trading requirement from government</li> <li>• opportunity to approach international technology</li> <li>• chance to enter a developing market</li> </ul>

Figure 3 Reasons for worldwide sourcing (adapted from Carter, & Narasimhan 1990.; Lysons, & Farrington 2006, 515)

### 2.1.6 International purchasing benefits and challenges

#### **BENEFITS**

In their research about characteristics and implementation of international purchasing, Monczka and Giunipero (1984) concluded some benefits of this type of buying activity with an emphasis on savings. Compare between a purchase obtained from worldwide and a similar purchase from domestic market, the savings percentage is about 10 to 20 for the first option. Besides, there are common qualitative benefits such as wider options for sourcing, quality upgrade, worldwide technology approach, competency and opportunity upswing, enhancement of competitiveness and shorter lead time. (7.). Birou and Fawcett (1993, 35) added the opportunities to benefit from better delivery and customer service, and the ability to enforce countertrade.

## CHALLENGES

Apart from opportunities, international purchasing may face several difficulties that either hinder a firm from adopting this concept or act as a motivation for company to overcome and stay competitive.

**Just-in-time sourcing** might be under pressure due to long supply lines and transportation problems, in some cases, these risks make JIT impossible. To manage such risks, buffer stocks are the must-have which definitely lead to the increase in costs of warehousing. The difference in **culture** can also cause hardship to international purchasing in terms of negotiation style, relationship, language style, time orientation, sharing of information, decision making and the extent to which people regard values. The transaction status and decision in sourcing can be affected by problems come from **politic and ethic**, especially when it comes to high risk countries according to *The Economist's* ranking and countries that compromise on cheap labour. Burdens derive from **communication** with suppliers, which is not only about language barrier but also about time difference and holidays, are annoying and may lessen the efficiency of the work. It is not always optimal to purchase from an oversea supplier for its more qualified products, as when any amendment is needed to be taken into consideration, it will be a hectic situation in which distance and transportation charge may add to purchasing costs. This circumstance is seen as **uncertainty in quality**. The **exchange rate** is another risk for international purchasing since the variation of global monetary values can sometimes make the buying company's payment exceed the agreed price. And the final constraint of worldwide sourcing is that it requires careful concern about legal aspect including country's law, different terms and conditions to protect the buyer, measurement unit variety, documentation for logistics, import duties, and so on. (Lysons, & Farrington 2006, 517-520.).

## 2.2 Artificial Intelligence

### 2.2.1 Definition

Before going through difference aspects of Artificial Intelligence, one must understand what it is about. Artificial Intelligence – abbreviated as AI, is a division of computer science, was described as the creation of intelligent machines by using artificial methods and know-hows to imitate, extend and augment the intelligence of human (Shi 2011, 1). In the long term, AI is expected to achieve human-level AI (McCarthy 2005, 39) and work out the complicated matters that a professional human can do (Shi 2011, 10). The AI systems are independent in the way that they are able to function without human's interference, they observe and learn the motif to decide and conclude actions through investigating distinct circumstances (Sousa, Melo, Bermejo, Farias, & Gomes 2019, 1). According to Kok (2009), there is no exact definition of AI because it changes along the evolution of technology development. Due to which, it can be understood as a system that think reasonably, act reasonably, think like a human and act like a human. (2.)

It was all began in 1943 when McCulloch and Pitts not only pointed out the ability to act or not act of the neurons in the brain cells but also insisted that they could learn and adjust their action through time. In the 1950s, Alan Turing – a British scientist, published a research covering the concern about if a machine can think (Warwick 2012, 2), and in this paper, he deployed a Turing Test to check the correlation between computers and humans in terms of intelligence. The skills required for a computer to succeed the Turing Test are:

- Natural language processing: ability to exchange information in ordinary language (for example English)
- Knowledge representation: ability to have and store knowledge
- Automated reasoning: reasoning ability formed on its knowledge
- Machine learning: ability to observe its surrounded condition and learn. (Kok 2009, 3.)

### 2.2.2 Elements of AI

AI is a broad concept; hence it is necessary to look at its correlation with other closely associated notions. The Venn diagram below will apparently show this idea.

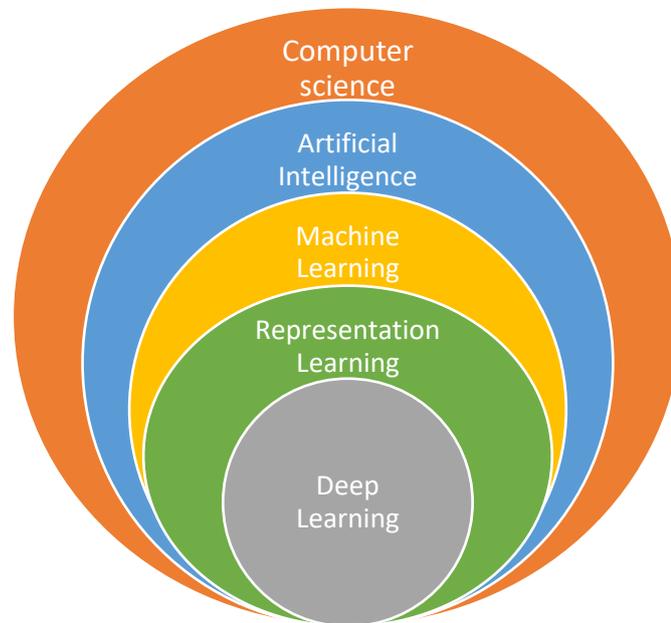


Figure 4 AI and closely related concepts (Adapted from Manandhar 2019)

As can be seen from the diagram, **computer science** works as an umbrella for other concepts, it is the initiation of anything relates to computers. **AI** is one of that “anything”.

Under AI is **Machine Learning**, which is the ability of a computer to automatically learn and utilize a set of data or prior knowledge/experience to advance its performance, without any apparent programming. Some examples of Machine Learning are classifying people through past data, handwriting, face, grouping people in the same segment, predicting price of a car, navigating ability of an autonomous car, computer playing chess against human player (Alpaydin 2010, 3.). AI and Machine Learning are usually mistaken to be interchangeable, but actually they are different, and Machine Learning should just be a subset of AI. From the beginning, it is known that AI is human-like intelligence of a machine, so Machine Learning can be seen as a machine’s process of learning to get to the point of being AI.

In order for Machine Learning algorithm to learn by itself successfully, the data it utilizes must be preprocessed and transformed into useful information (Bengio, Courville, & Vincent 2013, 1798). Because of this, the concept of Representation Learning was brought about as a subsidiary of Machine Learning. **Representation Learning** is the ability of learning algorithms to perform classification or prediction from drawn-out valuable information by independently learning representations of data (ibid.).

Representation Learning comprises of Feature Learning and Deep Learning. While Feature Learning is a traditional algorithm, Deep Learning is a more recent one, which has been blended with Representation Learning when it becomes deeper and more complicated, to ensure the efficiency of learning data's representations (Zhong, Wang, Ling, & Dong 2016, 3.). **Deep Learning** is a method of learning diverse level of data's representation, which is built in hierarchy, in which lower-level concept defines the higher-level concept. The higher-level concept is always more abstract than the prior one. With this ability, Deep Learning can learn complex functions of data representations that include various amount of abstract levels. The application of Deep Learning can be spotted in speech and image identification, drug determination, natural language interpretation, and so on (LeCun, Bengio, & Hinton 2015, 436.).

From this study of different terms related to AI and their connection, it can be concluded that AI is driven by Machine Learning algorithms, and Deep Learning is an evolution of Machine Learning that enhances Machine Learning's existed capabilities (Taddy 2018, 2-5). So, what does AI need to fully function? The following figure will give an answer to this question.

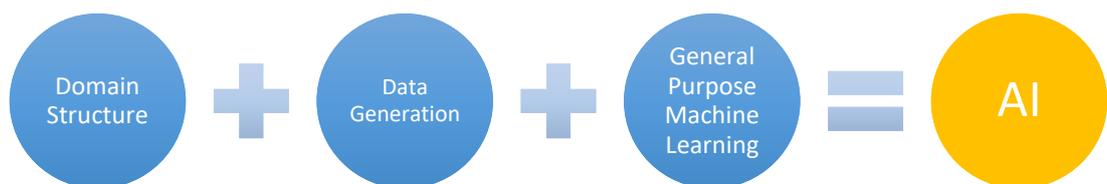


Figure 5 Elements of AI (Adapted from Taddy (2018, 2))

The first element of AI is domain structure, which permits separating an intricate issue into a mix of different tasks for Machine Learning to solve. One example for domain structure is that for a computer to correspond to customers, a customer's eagerness and intentions must be listed and arranged in a way that Machine Learning can establish diverse dialogue alternatives for each of them. The second element is data generation, or data collection. To make it possible for the system to learn, a stable flow and a massive number of useful data is required. The larger amount of data is provided, the wider scenarios system experiences and hence it can interact successfully with more real-world cases. Machine Learning is obviously an indispensable component when it is said to be an electric motor for AI. (ibid., 2-18.). The idea of Machine Learning was discussed in the previous paragraphs.

### 2.2.3 Types of AI

The norm for identifying a type of AI is to base on the fact of how much an AI system is able to imitate human. There are two ways to classify AI, one is based on functionality and one is based on capability (Upadhyay 2020).

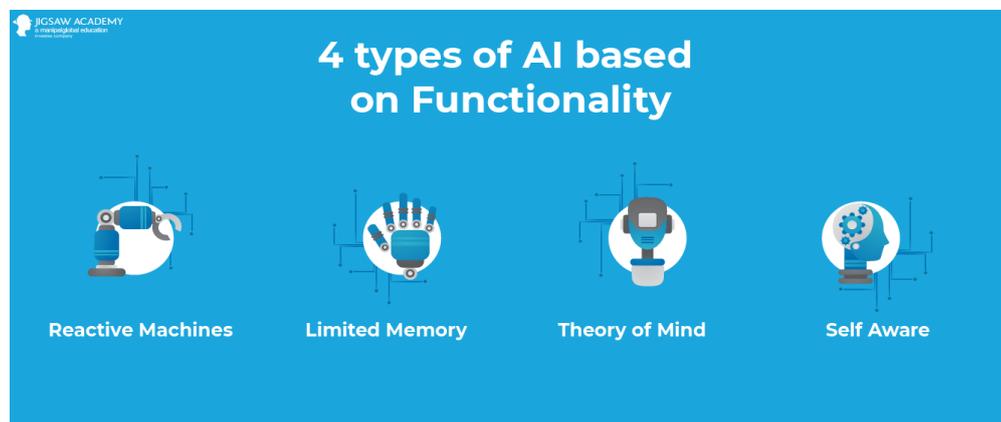


Figure 6 Four types of AI based on functionality (Upadhyay 2020)

If it is categorized according to functionality, AI includes four types: Reactive Machines, Limited Memory, Theory of Mind and Self Aware.

**Reactive Machines** are the initiation of AI and they have very simple capability. They cannot learn from the past experience to improve present actions but can just

perform based on a limited pre-setting. An example of this type of AI is the IBM's chess machine called Deep Blue, which won against the world chess champion Garry Kasparov in 1997.

**Limited Memory** machines have exactly the same ability as Reactive Machines plus the competence of learning from the past data to decide next actions. These machines use the techniques from Deep Learning. The applications of Limited Memory are familiar in nowadays world, such as chatbots, self-driving cars, virtual assistants.

**Theory of Mind** is a concept that is in progress of research and innovation. This type of AI is capable of knowing deeply about the individual it is communicating with by means of perceiving and differentiating the person's thinking, desire, belief and feeling. To achieve the level of Theory of Mind, other divisions of AI must be advanced because human's mind is extremely complicated and is impacted by different aspects.

**Self-aware** is presently just a hypothesis and this type of AI is being strived for by most of AI researchers as an ultimate target. Self-aware AI has not only the ability of Theory of Mind but also its own thinking, desire, belief and feeling. As transcendent as it sounds, this could be an evolution of technology but at the same time a threat for human. (Joshi 2019.).

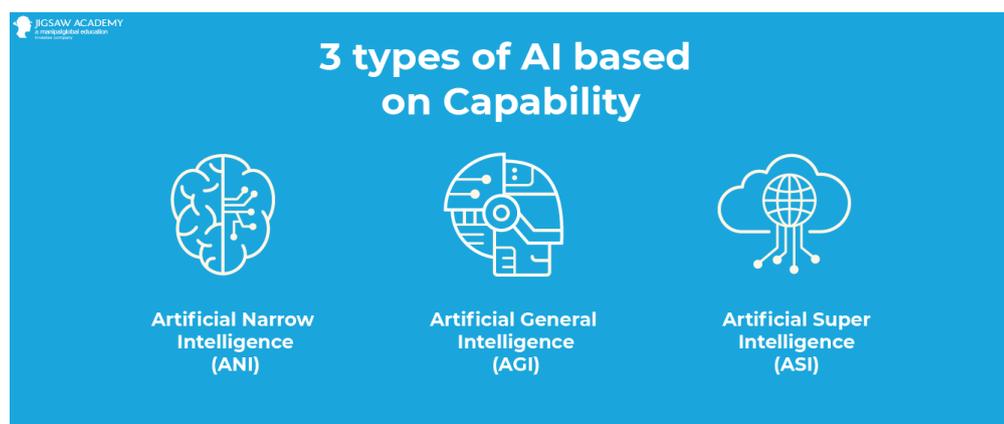


Figure 7 Three types of AI based on capability (Upadhyay 2020)

If it is categorized according to capability, AI includes three types: Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI). These are the names that are heard often in technology lingo (Upadhyay 2020).

Artificial Narrow Intelligence (ANI) has a limited scope, so it can be regarded as weak AI/Narrow AI (O'Carroll 2017). The performance of ANI is only limited to one particular assignment that it is programmed to carry out. All the AI that has been developed until today is under ANI, which means Reactive Machines and Limited Memory lie in this group, and so do Machine Learning and Deep Learning-based AI systems. (Joshi 2019.). Some examples of this type of AI are Google Search, virtual assistants like Siri, Alexa, Cortana, software that recognises faces, disease diagnosing equipment, robots, content filter tools for social media, self-driving vehicles (O'Carroll 2017).

Artificial General Intelligence (AGI), or strong AI/Deep AI (ibid.), holds the idea of Theory of Mind. AGI systems can autonomously fabricate different skills and structure associations and speculations across domains, greatly eliminating time required for guidance. A next level of AGI is Artificial Super Intelligence (ASI), to which extent the development of AI might reach climax. ASI systems are expected to not only imitate human's sophisticated intelligence but also make the most of their enormous memory, brisk data handling and reasoning, and managerial competence towards decisions to strive for excellence in anything they do. (Joshi 2019.).

#### 2.2.4 Directs of AI

AI has three major areas: computer vision, speech recognition, and natural language processing (NLP) (Yeung 2020). Their definitions and aspects are indicated in the following table.

Areas	Descriptions	Aspects
<b>Computer vision</b>	Computer's ability to see	<ul style="list-style-type: none"> <li>• Object identification</li> <li>• Tracking of object's motion</li> </ul>
<b>Speech recognition</b>	Computer's ability to listen	<ul style="list-style-type: none"> <li>• Composition of speech</li> </ul>

		<ul style="list-style-type: none"> <li>• Dictation of speech</li> <li>• Understanding speech's meaning</li> </ul>
<b>Natural Language Processing (NLP)</b>	Computer's ability to communicate with natural language	<ul style="list-style-type: none"> <li>• Translator</li> <li>• Information retrieval</li> <li>• Questions answering assistant</li> </ul>

Table 2 Three major areas of AI (Adapted from Yeung 2020)

### 2.2.5 Applications of AI on industries

According to Oke (2008, 1), there have been several research about AI for almost every fields until now such as finance, business, law, education, engineering, accounting, economics, medicine, science and marketing. In this chapter, some popular adoptions of AI in real world will be revealed to see how it is successfully applied.

In **manufacturing**, the machine vision in machines grants them the ability to observe the production line and detect any flaws, even the microscopic ones that human's eyes cannot recognize, then send warning. In addition to this, AI can help prevent failures by predicting the risks of failures and enabling predictive maintenance with machine learning. AI is also a part of product design phase when it generates different alternatives for specified requirements in no time, which helps save time and even discover ways that human could never think of. A more advanced application is digital twin, which is a replication of real world, in where human can create and test and run simulations for his creation before bringing it into physical build. NASA was one of the initiators in applying digital twin. (Polachowska 2019.).

When a person searches for a certain product online with only some terms related to it, the search engine gives a list of possible results that are exactly the ones which the person is looking for and also other recommended related products. This is a **marketing** strategy using AI. In **banking**, AI-based virtual assistants called chatbots have been helping answer simple questions from customers and Deep Learning systems have been used by MasterCard and RBS WorldPay to detect fraud transactions and card usage. In **agriculture**, automation and computer vision-based robots and applications

have been developed to detect and take actions on deficiencies in plants and soil, leading to a more sustainable use of agricultural resources. (Johari 2020.). AI is also applied in **healthcare** when Deep Learning allows AI to diagnose diseases as precise as healthcare professionals and even develop treatment for those diseases. Moreover, AI chatbots can assist booking for patients and Machine Learning systems can keep track of patients' information. (Vajradhar 2020). In **transportation**, AI contributes to introduction and development of automated vehicles and truck platooning, which boosts this industry to a next level and enhance the safety of on-road driving. Besides, AI systems give real-time data on routes and traffic to recommend optimal routes and avoid traffic jam. (European Parliament 2019, 3-4.). In **Logistics**, AI helps save time, costs, and rise productivity for back office functions; provides predictive Logistics like assist planning lanes and networks for air freight, predicting transit time, demand and capacity, optimizing delivery routes; implements logistics operations like inspection and sorting, material management with robots, autonomous vehicles, conversational user interfaces and computer vision applications. (DHL 2018, 22-32.).

#### 2.2.6 AI in Vietnam

Vietnam has been developing and becoming an integrated economy in South East Asia in the last thirty years. Worldwide, countries with strong economy are seeing AI as a core aspect contributing to their development. Given the target of stepping into global marketplace and leveraged by the urge of integrating into 4.0 technology revolution, Vietnam has been aiming for augmenting AI, which is forecasted to be the most breakthrough technology in the next ten years. (Pham 2019.). In 2014, the government included AI in the list of technologies that require implementation and growth focus (Artificial Intelligence application in Vietnam and future development trend 2020).

The following SWOT analysis will provide an insight on the state of AI in Vietnam in the recent years.

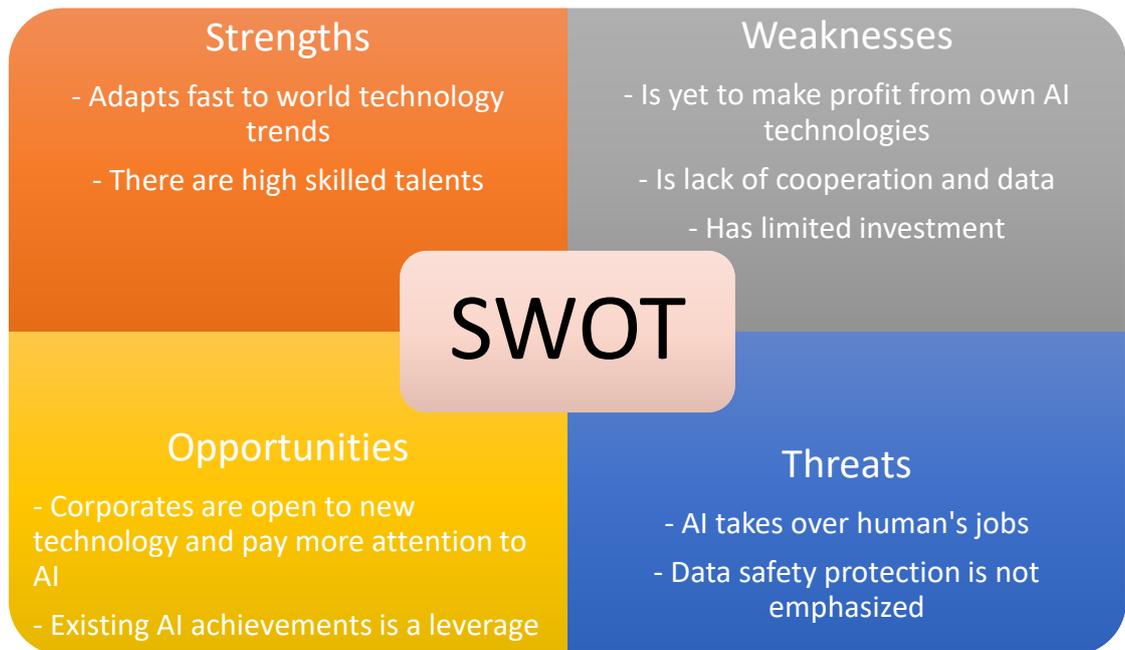


Figure 8 SWOT analysis for current state of AI in Vietnam

### STRENGTHS

It can be said that Vietnam is a country that always strive for keeping up to date with the world's technology development, remarkably the event that Vietnam is one of the first countries worldwide adopting 5G (VTV24 2020). Vietnam has been going on a bright path in terms of AI as AI industry was reported to develop 70% in 2018 compared to the previous year (Pham 2019). The work force in information technology of this country is potential as Vietnam invests a lot in the education of this field, creating high skilled graduates. Due to which, in the recent years, Vietnam has successfully applied AI into several industries including information and communication, healthcare, tourism, transportation, business and e-commerce. Notably, FPT Corporation is the first and only owner of a comprehensive and innovative AI platform in Vietnam until today. It has introduced different types of AI products such as chatbots, speech recognition and processing systems in automated answering services, photos and documents processing systems for identifying faces and IDs, and knowledge-based systems. Apart from these, voice recognition services in audiobooks, customer services, or automated newspaper reading; Natural Language Processing focusing on Vietnamese language for virtual assistants; IBM WFO – a system that assist doctors consulting and supporting cancer treatment; electronic medical records; Vinpearl's face recognition

systems for tourists are the most striking applications of AI in Vietnam. (Artificial Intelligence application in Vietnam and future development trend 2020.).

## **WEAKNESSES**

Even though Vietnam is integrating into AI trend like any other countries and has brought about a significant number of AI applications, it is facing some challenges that hinder the country from uncovering its full capability. According to Mr. Bui The Duy, Deputy Minister of Science and Technology, the corporations that have been applying AI in their operations are now mature, but more ambitiously, businesses are expected to be capable of creating products and selling AI technologies from those products. Moreover, it is reviewed that Vietnamese IT research teams lack of cooperation, so Vietnam is yet to own any core AI product. Big Data is also a problem in Vietnam as the country has abandoned storage of data, which is a huge barrier for developing AI. And the last constraint is the lack of investment, or in casual word, lack of money. Due to which, Mr. Bui The Duy emphasized on the assemblage of mankind and data. (Lam 2019.).

## **OPPORTUNITIES**

In the future, the opportunities for AI is definitely broad since corporates in Vietnam are more open to new technology and they have been willing to invest in AI projects, even for small companies and start-ups. Conferences and educational programmes with AI as a topic have also been organised to train Vietnamese talents and boost AI applications in Vietnam (The Case for AI Research in Vietnam 2019). Moreover, the present success in inventing AI products and applying them in different sectors can act as a fundamental for future development of more advanced AI applications in the country.

## THREATS

As the involvement of AI increases, human can face the risk of losing their jobs to this technology. Especially for low-wage jobs, they are usually repeating jobs that can be performed without high skills, are soon to be replaced with automation. The jobs that are normally outsourced to poorer countries like India, China, Vietnam and Thailand from developed countries can be taken over by AI, leaving behind under skilled jobless people. (Will AI kill developing world growth? 2019.). AI deals with Big Data, so it can bring about many problems related to data protection. In a country where cybersecurity is not widely acknowledged and focused on like Vietnam, which is proved through the unawareness of keeping personal information safely, respecting other people's personal data, or the right to deny providing personal information, this is a big threat.

With the motto "Invented for life", not only company B but also other branches of R GmbH worldwide take innovative technology as a centre in improving life. For AI alone, the corporation is spending 3.7 billion euros per year on software development, recruiting 1,000 AI experts, and providing multilevel trainings for managers and employees working in the field. With an aim to bring up an easier and safer life for people, R GmbH have adopted AI solutions in mobility, household and manufacturing. (Invented for the future and beyond.). They are listed in the following table.

Areas	Solutions	Targets
<b>Mobility</b>	AI-enabled driver monitoring system	Analyses drivers' gestures and postures to prevent accidents by drivers falling asleep
	AI camera	Performs automatic emergency breaking
	Virtual Visor	Protects drivers' vision while driving
<b>Household</b>	Intelligence camera with sensor	Gives alarm in case of fire or intrusion

	Smart Home appliances	Assist in kitchen and adjust house's temperature
<b>Manufacturing</b>	Predictive maintenance and autonomous machines	Reduce repairing time and defects in products

Table 3 AI solutions of R GmbH (Adapted from Harnessing the power of AI to improve technology)

### 3 Research methodology

#### 3.1 Research approach



Figure 9 Research approach

Research objectives were defined based on the author's observation at the case company, interviews with purchasing department's associates, trusted websites and scholar articles. Following by that, research questions were formed in accordance with the research objectives. Then, theoretical materials were gathered to gain a comprehensive understanding about different aspects of the research topic. After that, the study on the case company's purchasing department's current state including purchasing process, systems used and efficiency of purchasing activities will be conducted. That phase will work as a fundamental for solution proposal and analysis of the solution application possibility such as in which areas and for which product categories the solution is most beneficial, the challenges of the solution. Then finally, conclusion will be made.

## 3.2 Data collection

As explained in the first chapter, qualitative research method was utilized for this thesis with case study. To perform a successful research, having sufficient and qualified data is crucial, and hence choosing adequate data collection methods plays a decisive role. Observation, interview, chronicle reports are the main methods of collecting data for case study and they were used for this research. In addition, literature review was also used alongside.

### **OBSERVATION**

The observation was done by a six-month internship at company B, when the author had an opportunity to obtain all necessary knowledge about purchasing job, to witness the working process of Purchasing Department, to do the actual daily tasks and to interact with experts of not only purchasing field but also other fields. By this way, the author could familiarize with the business and realized some challenges it confronted.

### **CHRONICLE REPORTS**

All information related to purchasing that is useful and crucial for understanding and implementing the job was noted down during the time spent at company B. It served as a beneficial tool for this thesis in terms of terminology, company's information, processes and events.

### **INTERVIEW**

To have a more objective understanding about the challenges that Purchasing Department were facing and figure out which aspects in purchasing can be improved with AI, an interview was conducted with four experts working in Purchasing Department of company B. The interview lasted around 45 minutes, took place on phone, Skype for Business, Messenger and Zalo due to the difference in interview participants' locations.

## LITERATURE REVIEW

In order to understand deeper about purchasing, know what Artificial Intelligence actually is and how purchasing at company B can benefit from it, a literature review was conducted to bring together information about different aspects of purchasing and AI, as well as AI's applications in reality. Moreover, previous research about applying AI into purchasing were referred to and used as a leverage for the author's ideas. The literature included Books, eBooks, articles and professional websites which was found from Google, Google Scholar, Janet and JAMK's library.

The following table will clarify the four mentioned data collecting methods and their purposes.

Methods	Sources	Goals
<b>Observation</b>	Six-month internship	<ul style="list-style-type: none"> <li>• Familiarize with purchasing process and activities</li> <li>• Realize inefficiency</li> </ul>
<b>Chronicle reports</b>	Personal notes Department's documents	<ul style="list-style-type: none"> <li>• Gain theoretical knowledge about the company, purchasing process and activities, systems</li> <li>• Look back at the faulty events and analyse root causes</li> </ul>
<b>Interview</b>	Interviews, emails, phone calls	<ul style="list-style-type: none"> <li>• Get experts' opinions about their responsible material categories, the obstacles in their jobs</li> <li>• Gain deeper understanding about process and systems</li> <li>• Observe experts' attitude towards AI</li> </ul>
<b>Literature review</b>	Books, eBooks, articles and professional websites from Google, Google	<ul style="list-style-type: none"> <li>• Understand deeper about purchasing and AI</li> <li>• Gain insights about applying AI into purchasing: in what areas, opportunities and challenges</li> </ul>

	Scholar, Janet and JAMK's library	
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Table 4 Data collecting methods and their purposes

## 4 Data Analysis and Findings

### 4.1 Purchasing process at company B

A purchase is always initiated with a demand. When end users are in the need of a product or service, they will send a purchase request (PR) on I-Matra system (which will be introduced in section 4.3), then a PO team is responsible for placing a purchase order (PO) to the predetermined supplier. However, it is not always the case that the PR is accepted and turns into PO. At company B, there is a notion called first value limit, which is a limit of purchase value at which the decision for Purchasing Department involvement is made. For purchase value of less than 12,500€, end users are allowed to buy directly from the supplier without the consultation from Purchasing Department. Otherwise, if the purchase value reaches or exceeds first value limit of 12,500€, it will have to go through a more comprehensive purchasing process, in charge by Purchasing team. The process is described in the following figure.



Figure 10 Purchasing process at company B

## **DEMAND**

End users have to identify the specification of the product or service they want to purchase in terms of quantity – how many units, quality – how qualified, delivery – when and how to be delivered, and budget – how much is to be willing to pay. Moreover, detailed description and/or technical drawings of the product or service must be provided to Purchasing Department for mutual understanding about the demand and ease of sourcing. At this stage, responsibility is of end user and support is from Purchasing Department.

## **SOURCING**

After receiving the specification from end users, Purchasing Department starts to look for suppliers. The suppliers are sourced through internet searching tools, company's system called I-Source, or nomination. Since the corporate is a global business, company B appreciates international purchasing, the suppliers can come from any countries but most of the time limited to ASEAN area and Europe. The minimum number of suppliers who are to go to evaluation stage depends on value limits, if purchase value lies between first value limit (12,500€) and second value limit (25,000€), 2 suppliers are needed, if purchase value is between second value limit (25,000€) and third value limit (50,000€), 3 suppliers are needed and so on. During sourcing phase, if buyer encounters a new supplier, buyer will send a request for information (RFI) to gather necessary information about the supplier's business including location(s), number of personnel, available products and services, ISO certificates and turnover. Once a list of potential suppliers is finalized, purchaser will then send the specification and a request for quotations (RFQ) to suppliers either through email or I-Source system. Suppliers are expected to quote with quality, delivery time, deliver terms and conditions, and prices. At this stage, responsibility is of Purchasing Department and support is from end user, who is the main contact with suppliers about technical and/or scope of work matters.

## **EVALUATION**

After receiving the quotations from suppliers, end user and buyer work together to implement comparison of quotation (CoQ) regarding prices, delivery terms, technical and/or performance ability. The suppliers must first be able to meet the specification of the demand product or service, then the price comes as a decisive aspect in most cases. During this stage, end user and buyer have to be in close contact with each other and with suppliers to make sure the requirements and quotations are understood correctly.

## **NEGOTIATION**

After CoQ is done, buyer conducts a negotiation with supplier(s) to get the best price from them. Sometimes, an auction is involved in cases when the market is competitive, meaning that many qualified suppliers (more than three) are capable of providing one product or service at the same quality level, high bidding package value (at least hundred thousand euros), and the buyer knows the price structure of the product or service. Company B uses two types of auction: English auction where the winner is the one who offers the lowest price after a certain period of time, and Dutch auction where the first supplier to take the offered price in a certain period of time during which the price proposed by buyer ascends from a bottom limit price is the winner. The one with the most competitive price will be selected as supplier for the demand product or service. At this stage, responsibility is of Purchasing Department.

## **CONTRACTING**

Purchasing Department will make a contract with the chosen supplier if the purchase value is significant. The contract covers scope of work, prices, both sides' rights and obligations, terms and conditions and duration. After that, a PO is released. If a purchase is not worth a written contract yet, a PO can act as a proof of relationship between the company and supplier.

## 4.2 Purchasing categories at company B

Purchasing at company B is categorized into direct purchasing and indirect purchasing. For Vietnam branch, direct purchasing team is responsible for Mobility sector, including materials such as machining materials and accessories for engines and other car parts. Meanwhile, indirect purchasing team is in charge of a wide variety of categories, serving not only Vietnam branch, but also Malaysia, Thailand, Indonesia, Singapore, Philippines ones.

### **MACHINERY, INSTALLATIONS, EQUIPMENT (MAE)**

This category refers to all machines serving the production in company B's factory. Since machines have long life cycle, the purchase for all of those new machines only happened at the time when company B began to build up its production lines. Due to its characteristics of being long term and big investment, the suppliers for MAE are nearly impossible to be changed.

### **TOOLING**

As shown in its name, tooling represents the tools that are useful for production. It includes subcategories that are standard tools – hand tools, hoes, shovels, drills, measuring tools like calipers; machining tools – grinding wheels, cutting wheels, grinding disc, cutting disc, cutting points, drill bits, chisels; customized tools for special processes for example polishing tools; and fixture which is custom-built based on the objects. Tooling is considered to be a very vital group of material because it decides the productivity and quality of the end products; due to which, this category's suppliers are hard to be replaced.

### **TRAVEL, MOBILITY AND MARKETING**

This category includes all the services serving the need of work travel, events, company's associates transporting, company promotion such as hotels, airlines services,

cars and shuttle buses renting and marketing campaigns. These services only support the running of the business, not directly impact on end products and customers.

### **INFORMATION TECHNOLOGY (IT)**

IT are the products that are indispensable for daily operational activities, they are hardware, software, computers, laptops, printers, photocopiers, mouse, headsets. As company B insists on genuine IT products, the suppliers have to be the manufacturers and company B conducts global contracts with them with global prices that are applicable for all branches of the corporate. However, not all countries are able to buy directly from these suppliers because of brand or representative stores' inexistence. In such case, they must establish a partnership with reliable domestic middlemen.

### **MACHINE COMPONENTS AND SERVICES (MCS)**

This category includes all the components for machines so that without which the machines cannot function, and production line will stop. This type of material is categorized into spare parts and machine services like preventive maintenance or machine upgrade. Usually, supplier of a machine is the one who produces and/or modifies its spare parts or buys some standard parts for their product. Therefore, MCS is an extremely important purchase category and alteration of suppliers is nearly impossible.

### **PERSONAL PROTECTION EQUIPMENT (PPE)**

Equipment whose aim is to protect the safety of workers in production activities and employees in operational activities lies in this category. Examples for this are work helmets, gloves, clothes, shoes, hand sanitizers and masks.

### **FACILITY CONTROL MAGEMENT (FCM)**

Facility control management includes work and services related to building operations for example office building, infrastructure layout, air conditioner systems, temperature control systems, humidity, wind, radiation fan and water systems. Moreover, it

covers hook-up materials like electrical, water and gas piping systems which are ready to connect to machines when they arrive at the facility. Besides, there are canteen, insect control, security, cleaning, system installation and maintenance services. FCM is crucial in a sense that it supports the production process and ensure proper products storage in the factory.

### 4.3 IT system for purchasing at case company

As one of the leading businesses in technology, company B pays close attention to optimizing the productivity of its operations, and Purchasing Department is not out of the scope that the up-to-date systems are applied to. SAP, I-Source, SRM and I-Matra are the most common used systems by buyers, directly or indirectly, to manage POs and relationship with end users and suppliers.

#### **SAP**

SAP is the system used for the whole company where all the activities of every department are integrated. POs that are usually released on SAP are POs for parts on stock, which are of recurring demand. Purchasing Department utilizes SAP to follow up those POs and view POs' information such as items, quantity, prices, order time, delivery time, invoices and payment status.

#### **I-SOURCE**

In the past, buying activities like requesting for quotations, negotiation, signing contracts were handled through emails and letters, but the introduction of I-Source has put an end to that time-wasting and untraceable way of working. I-Source is a purchasing tool to process purchase requests, which are order whose value is higher than 12,500€, recurring services or new order, coming from end users. The working process for a purchase on I-Source after a PR is raised is Action Plan (buyers' plan regarding sourcing time, negotiation strategy) -> Market Survey (RFI) -> RFQ -> Pre-sourcing meeting (request for strategy approval from managers) -> Approval from managers ->

Award the supplier on the purchase package based on CoQ -> Contract. Transparency is a characteristic of I-Source because every action taken during this process can be tracked by Central Team in real time and cost saving is automatically calculated.

### **SRM (SUPPLIER RELATIONSHIP MANAGEMENT)**

SRM is a platform that stores all information of suppliers who have done business with company B including organizational information like company scale (global or local), subsidiaries, turnover; performance when providing products or services for company B; and contracts. Using this tool, buyers can have an overall and objective understanding about the existing suppliers.

### **I-MATRA**

I-Matra is a system that connects all the shopping carts (purchase requests) from end users. This system is linked with I-Source system in a way that the I-Source number for the PR must be on I-Matra and I-Source processes the PR raised on I-Matra. After results are released from I-Source, I-Matra will hand them over to the PO team.

## **4.4 Challenges in purchasing process**

### **4.4.1 Problem with systems**

The benefits that adopted systems have brought about are undeniable: reducing manual work – buyers no longer need to send RFI and RFQ separately to each supplier through email, documents are easily tracked without scrolling thousands of emails or hard copies, information is transparent and streamlined. However, there exists some obstacles that users are facing related to these systems.

For anything that is newly adopted, it takes time to understand and get used to it. This case is not an exception, especially when the systems are of IT, which is usually regarded as a not-so-easy to get familiar with for ones who do not have education in the field. Having many systems requires the buyers to have good knowledge, briskness

and flexibility to manipulate each system effectively and switch between systems, which creates a high possibility of missing information. Beside buyers, suppliers, notably new suppliers, are also the ones who suffer from difficulties doing business with company B. I-Source system's template is evaluated to be not yet user-friendly. Moreover, the system demands terms and conditions acceptance from suppliers whose level of English is limited to daily conversation and own fields of businesses; also the suppliers are confused about the process to log in into the system, to fill in information or to bid on the system. Because the suppliers are used to their own way of quoting prices, it takes time to contact back and forth through emails about how to use the system or in a worse case, the suppliers drop the cooperation.

Regarding the SRM system, it is useful for buyers in a way that they can track suppliers' performance to select a vendor for a project or communicate with them about how well they are fulfilling their duties. To evaluate a supplier, price, quality and delivery are the main criteria, which need insights from buyers, end users and Logistics Department. However, as the access to SRM is limited to Purchasing Department, the information inserted is manually collected by buyers, which is sometimes missing, unreliable or unobjective. As a result, it hinders negotiation with suppliers.

When there are various of systems with users from different departments, they need to be linked to ensure a streamlined workflow and this can be a source of potential problem. In a circumstance when there is a fault or change happening, it will create a system bottleneck and affect the whole operation. Moreover, each process on the system has a responsible person, but the person's name is kept confidential, so if a problem occurs, there is no way to reach out to the right person and solve it quickly. Another aspect that people care about when adopting a system into their operation is the improvement of working speed. Indeed, SRM system stores all the suppliers' information and it can show suitable list of potential suppliers according to the buyer's needs, but it takes time to filter the criteria and the buyer has to consider each of the supplier from a long list. Therefore, the sourcing speed is not optimized yet.

#### 4.4.2 Problem with suppliers

For company B, the biggest problem when it comes to supplier relationship in international purchasing is language and culture barrier. Even though the suppliers are of global corporates, the branches which are to buy from do not have skilled English language sellers, so there must be local co-workers from R GmbH in the country that the suppliers locate to act as communicators. In some cases, due to limited English skills, misunderstanding happened, and it took several days to solve a trivial problem. In the long run, it will do harm to the cooperation. Besides, culture barrier can affect the negotiation. Some cultures appreciate direct communication and fact focusing while others prefer human's relationship and affection, so it is a difficult situation for those who do not have enough experience interacting with various types of culture.

In addition, understanding and capturing foreign market and law are challenging. What if there are new valuable resources? What if there are good suppliers with competitive prices who are only familiar locally? What if the supplier is a fraud? One can hardly know since Google's search tool tends to show much less information when the search is aimed at other countries. So, it depends on the buyers' experience and connection. Moreover, each country has its own business laws and without being acknowledged about it, both sides can get to conflict in contracting and one party must compromise, or both abandon the partnership.

#### 4.4.3 Problem from internal

The world is changing every day and hence new trends, new markets, new products are introduced continuously. This is a common challenge that buyers are triggered to build a brisk attitude and a wide vision.

Streamlining information in a supply chain is very important. However, this is still a problem in company B. Sometimes, it takes more than one person to deal with the supplier (for example new employees taking over), and negotiation result from the first round achieved by the first person is not fully passed on to the second one, which leads to confusion in the conversation and the supplier can dominate the purchaser to

buy with the original price. When it comes to big projects or projects that involve several departments, it is acknowledged that the information is not updated among relevant sides. Another common problem is that end users do not know where to look for suppliers' contact information and they are unable to realise the categories of which their purchase requests are, which lead to a habit of their contacting random buyers to ask for matters that are irrelevant to the buyers' responsibility.

In addition, end users often complain about the slow PR processing action by buyers. This is because of the lack of networking between buyers and end users, that is buyers are not early involved in purchasing planning stage with end users, but instead, they can only take action once PRs are raised. By this way, buyers cannot give advice on the end users' plans so as to make it faster to find the suppliers and to make the negotiation with suppliers more achievable. Occasionally, buyers and end users do not share the same opinion regarding suppliers when buyers prioritize suppliers with competitive prices while end users highly evaluate good quality. Due to which, a difficult circumstance arises as end users insist on keeping recent suppliers, but buyers want to look for new ones.

Another problem is related to reporting. The reports are not fully automated and real-time, but they are made for the previous month or year, which means whatever problem has happened, it is to be known after a certain time. As a result, the problem cannot be solved at the time it occurs, it is the consequence that has to be worked on eventually. For example, one time, there were wrong payments made by company B to a supplier due to wrong prices in the invoices which were not aligned with the contracted prices. It was not until the second year that the problem was spotted, and it took half a month for three departments of company B and the supplier to settle it.

Apart from problems that occurred subjectively, there were unpredictable cases when company B could not prevent them from happening. One remarkable case was the outbreak of Corona virus. Certainly, Corona virus has affected not only Vietnam but also any other countries in the world, causing loss of human lives and disruption of economy. Purchasing Department of company B was not an exception when suffering

from shortage of supplies, difficulty in price negotiation, suppliers' bankruptcy, delayed delivery.

## **5 Solution**

### **5.1 AI as a solution for purchasing**

Lean is a concept that was brought about by Taiichi Ohno at Toyota Motor Corporation with the motto of using less resources to create more of products and services. The aim of lean is to reduce any possible waste in manufacturing procedure, such as over-production waste, inventory waste, defects waste and waiting waste, ideally to zero. In the beginning, lean was supposed to be used for manufacturing field, but through time, it was expanded to service sectors as well. (Goetsch, & Davis 2013, 508-509.) It is no doubt that many big corporates like Nike, Intel, Caterpillar Inc. and Ford have been adopting lean to their processes and company B is not an exception. In this fast-paced world today, creating more value with very limited cost is certainly an aspect to prove a business's competitiveness, so it makes sense to cut down on human's effort and enhance productivity of a back-office activity like purchasing. And, AI can be a solution for that.

#### **DATA EXPLOITING AND ANALYSING**

Sourcing, one of the most important activities of purchasing, can be done with Google, with buyers' experiences, and with SRM system, but takes at least one morning (roughly 4 hours) for a small-scale project. AI only needs one second. With Machine Learning, an AI system can scan the big data of suppliers across different databases, both private and public, to give recommendation on suppliers whose characteristics are closest to the buyers' criteria. The pre-eminence of AI is that it reacts to every detailed criteria which present SRM system's filter is limited, it provides less amount but more relevant results to choose from, it can wholly access to foreign markets

and their regulations, and it dismisses nomination of Google for paid advertisement by some businesses who want to boost themselves to the top appeared results.

Moreover, the data that AI exploits is real-time data. AI can keep up with the most updated world's situation, businesses' state, market trends to avoid suppliers from areas with crisis, economic disruption, money devaluation, inflationary, and to prepare for the worst situations like wars and pandemics. AI can also recognise real-time problems and give alert so that buyers can look into the cases and take timely corrective actions.

### **SUPPLIERS RELATIONSHIP MANAGEMENT**

Language is no longer a barrier with the help of AI. In a click, an AI system can translate a document from English to all languages or act as an interpreter for a conversation between a buyer and a supplier from different countries. Taking this further, it even portrays the supplier's emotion and guide the buyer to a more appropriate communication way. By this way, both sides can be happy and understand each other well. In addition, for the cases when suppliers are confused about how to respond to company B's system, AI can give guidance, even in their languages.

Another aspect of supplier relationship management is negotiation. When it comes to negotiation, it is an obvious sense that only physical human is able to perform the task as it requires human's feelings in the conversation, buyers' experiences and skills. However, a research by Schulze-Horn, Hueren, Scheffler and Schiele proved that AI can contribute to the success of a negotiation. They stated that with Machine Learning, AI has the capabilities of:

- Utilizing cost-optimizing engineering: realizing the opportunities to cut down on manufacturing costs without interfering with the products' quality and functionality in order to decrease the purchasing costs
- Analysing cost-breakdowns: identifying any factors of hidden costs in the cost-breakdowns given by suppliers

- Recognizing price patterns: predicting how the prices are changing over time to plan the sourcing period intelligently
- Assisting mechanism design-based negotiations: looking into suppliers' negotiation patterns to predict their behaviour and possible outcomes of the negotiations. Then AI could recommend suitable negotiation rules in accordance with each demand and market situation. (Schulze-Horn, Hueren, Scheffler, & Schiele 2020, 627-633.)

### **OPERATIONAL ACTIVITIES OPTIMIZATION AND STREAMLINE**

It is highly recommended that AI should be a system that links with other existing systems and accessible for every department so that the workflow is streamlined and avoid anyone's time consuming. Allowing that, AI can track suppliers' performance through delivery time, product quality control by engineers, end users' satisfaction about the collaboration and pricing to release comprehensive evaluations without the buyers' effort to contact related departments. Additionally, since end users have access to all the transparent and valuable information in terms of suppliers synthesising by AI, they will be able to understand the reason behind buyers' sourcing decisions as well as to give helpful inputs. Also relating to this, AI can realise the opportunities for buying and early involve in planning stage with end users. Nevertheless, the linking of systems to AI will not face the risk of bottleneck when a problem occurs thanks to the real-time characteristic of AI as stated in the previous part.

Purchase classification is most of the time a challenge for end users. AI can use Machine Learning to identify which category does a PR belong to and address end user to the right buyer. For a spend, Machine Learning enables AI to categorise it into the right product group despite the description differences in general ledger, invoice, PO and supplier's database.

Contracts play an important role for purchasing since all prices, payment terms, validity, rights and obligations do matter. AI using Natural Language Processing will be able to assist buyers in contract drafting by learning previous contracts' style and content, then bringing the buyers' ideas into the document at the right place and in a meaningful way. By this way, buyers can save tons of time going through every word in the

contracts. Moreover, with the ability to scan critical information in the contracts, AI can collate contracts with invoices to ensure correct payment and/or give alert about suppliers' obligations disobedience. In the end, the contracts will be automatically saved into SRM system with auto-extracted critical information such as suppliers' names, product categories, validity, responsible buyers and user departments.

Last but not least, since AI is a storage of data, information is fully transferred from generation to generation. The predecessors will not have to worry about if their knowledge and materials are passed on to the successors fully or not, if the successors can handle the aborted cases thoroughly, if the newcomers understand the company's long-time suppliers. As a matter of fact, in this day and age, human's experiences are no longer important, it is the analysis, synthesis and communication skills, which can be achieved by AI.

## 5.2 AI application with product categories

The benefits of AI on purchasing were acknowledged, but it is also important to look into which product categories can benefit most from this technology.

Taking direct materials and indirect materials into account, AI is more applicable for purchasing of indirect materials because it includes many more sub-categories, which means it requires more purchasing activities. Moreover, based on the fact that direct materials are physically of the end products, they are rarely changed or removed unless the company wants to stop manufacturing those products. Due to this characteristic, the spend value for one direct product is much higher than that for an indirect product, meaning that a contract with supplier of a direct material can last for several years compared to an indirect material contract. So, direct materials demand lower frequency of sourcing. In addition, internally, direct materials buyers only deal with the end products manufacturers, in this case Mobility production teams, while buyers of indirect materials receive purchase requisitions from different departments of the corporate, domestically and internationally. Hence, indirect buyers have to face with disparate types of end users.

For indirect materials, MCS materials are endless, but as stated, they mostly come with the machines, so the buyers' main task is to negotiate with exclusive suppliers providing those machines' spare parts rather than looking for random suppliers. Regarding PPE materials, as there is a certain list of what equipment is used for protecting workers' safety, the variety of this category is low. For MAE products, due to its characteristic of having long life span, buyers for this category only concentrate on buying small machines whose spend value is insignificant, at the moment. About FCM materials, for some areas such as cleaning, surrounding environment care and infrastructure management, the suppliers can be bundled, which means one supplier can supply their products and services for several branches of a business around the world. And for a distinctive area like construction, local suppliers are preferred.

The purchasing of travel, mobility and marketing, IT, tooling has the same characteristics that are buying for R GmbH in at least two countries, new projects occur regularly, and the market is shifting every day. Based on that, buyers for these categories are more likely to run up against the challenges in international purchasing, they need wide connection and they have to keep up with the ever-changing market. Therefore, it can be concluded that among the seven sub-categories of indirect purchasing, travel, mobility and marketing, IT and tooling are the ones that will take the most advantage of AI.

### 5.3 Challenges of applying AI into purchasing

Although AI has proved its success in industrial and other business sectors, it is rather new for Purchasing. Therefore, this technology has unavoidably received some doubts about its applicability in terms of investment, legality, quantity and quality of data. However, these are common obstacles for any new technology that are to be adopted, so with careful consideration, it will be a practical application in the future.

## INVESTMENT

Like any other systems, AI is not a cheap solution to adopt. As Machine Learning and Deep Learning need a large number of cores and GPUs to work, computing power from supercomputer, which is expensive, is required. Even though Cloud Computing can be a substitution for that, its cost is significant (Vadapalli 2021). According to cost breakdown for an AI project given by TP&P Technology, a development of AI can cost up to around 100,000€/project (120,000\$/project). The development phases and their costs are illustrated in the following figure.



Figure 11 AI development cost break-down according to project stage (TP&P Technology 2019)

However high the initial investment is, company needs to take into consideration the long-term benefit that AI can help increase savings for the department's operation.

## LEGALITY CHALLENGE

According to a research by Perc, Ozer, and Hojnik (2019), the adoption of AI can interfere with many aspects of legality. One of them, which is most related to Purchasing as well as company B's main concern in any activities, is data jurisdiction. As the size of data and the need of data collection and analysis increase, alongside with the fact that Big Data is claimed to be opening a new era of innovation, companies are exploring ways to make benefit from this, which triggers legality relating to "information explosion". Company B has to answer to questions of if they are willing to trade the data,

what data they want to use, what data they are eligible to use and what laws they will apply to control that. Company is challenged to make sure data is used in a beneficial way but at the same time in a privacy protected, non-discriminated and values respected manner. (3-5.).

## **QUANTITY AND QUALITY OF DATA**

In order for AI system to learn and behave like a real human, the data set from which it learns should be not only broad but also qualified. Obviously, data is the crucial part of AI. Without a significant set of data, AI cannot perform or give any predictions. As a matter of fact, before learning the data, AI is neutral, it does not know what is right or wrong, it does not have opinions but only learns from others' opinions, so one must make sure the inserted data is correct and unbiased. Biases in data can be racial, ethnic, gender or communal biases. For example, if the data is collected from a group of end users who are xenophiles, AI will tend to neglect local suppliers when buyers do sourcing, which can lead to missing of good qualified domestic suppliers with the chance of better delivery. Bias can also be a result of data scarcity, so both quantity and quality affect each other and affect the learning of system.

AI seems to be an ideal platform, but is it trustworthy? This might be a question that is asked the most. Everything has flaws, so does technology. An AI can sometimes make mistake and it does not have feelings and real-life experiences, so it cannot work fully independently, it needs the involvement of real buyers.

## **6 Conclusion**

The main objective of this research was to propose a solution that helps the commission company save the costs of purchasing by decreasing human's effort but optimizing job productivity. There are three research questions and they were answered throughout this study.

- **What is the purchasing process implemented by Purchasing Department of company B? What kind of products and services is company B buying?**

The questions were fulfilled by the author's observation during her internship at company B. In addition, an interview was conducted with four senior buyers from Purchasing Department of company B to gain deeper understanding about the purchased materials. The purchasing process and seven different product categories were described in section 4.1 and 4.2. Thanks to thorough study about the characteristics of each type of material, the conclusions about purchasing of what material can benefit the most from AI could be made.

- **What are the challenges that Purchasing Department of company B is facing in its daily activities?**

Through self-experience and interview with the four experts, the obstacles faced during daily purchasing activities were revealed. The challenges that Purchasing Department of company B has been facing are equivalent to common problems caused by international purchasing and working in large corporates. They are inefficiency in existing systems, problem managing supplier relationship, unintegrated internal work and information, and risks from objective incidents. Of which, the systems adopted by company B and the vulnerabilities around them were closely looked into to build the desired characteristics of a more advance technology.

- **How can AI be applied to get rid of the purchasing inefficiencies? What opportunities does this solution bring and what are the inadequacies?**

AI was suggested as a solution for enhancing purchasing performance at company B. AI's abilities were introduced parallely with how it can solve current problems in the purchasing process. Firstly, it can fulfill the flaws of current adopted systems, acting as a more user friendly, faster and more productive platform. More importantly, AI enables a perspective that is crucial for every nowadays activities – real-time. Secondly, it can assist in managing relationship with suppliers through putting down the border of languages and culture between countries, providing a more comprehensive supplier evaluation, and bringing price negotiation to the next level. Thirdly, AI can improve internal operations a lot with information streamlining, purchase

classification, contract drafting and departments connection. The applicability level of AI into the purchase of different product categories was also analysed and a conclusion was made that indirect purchase, of which travel, mobility and marketing, IT, and tooling are the most beneficial purchase categories from AI.

Apart from the good side of AI, its imperfection was brought into the discussion to give a comprehensive view for the solution. The obstacles from investment, legality, and quantity and quality of data can hinder the application of this advance system. However, those are just trivial matters and can be taken into account if the business really considers about the long-term benefits it will bring.

In conclusion, even though AI seems to be an ideal solution, it was proved to be capable of optimizing purchasing activities in this research. Moreover, it is not something extraordinary, but it has been successfully utilized in other business sectors and a small part of it actually is existing in current adopted systems of company B's Purchasing Department. It is believed that AI will be an unreversed trend in the near future, especially for multinational enterprises.

## **7 Discussion**

The idea of applying AI into purchasing was discussed in the beginning with some purchasing experts of company B and received good evaluations as well as a promising sign of this technology's adoption in the future. It was shared that company B has actually been trying to involve some AI's abilities into the systems equipped for Purchasing Department, so AI is not a fantasy. Due to which, the suggested solution from this thesis is associated with company B's development strategy.

The limitation of this study lies in the lack of IT Department involvement, which leads to the inability to check the possibility of applying this technology into purchasing and detailed instruction on how to put it into use. Moreover, due to company B's strict data protection regulation, some numerical data could not be utilised to implement a deeper analysis for the study. This solution was based mainly on theoretical review,

also simulation could not be run at present to measure the extent of success. Therefore, further research with longer time frame is suggested to study how to technologically insert AI into purchasing process.

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## Appendices

### Interview questions

1. What is/are the product category(ies) you are responsible for?
2. What are their monthly spend value in the last year (2020)?
3. How do you evaluate the importance of your product category(ies) to overall company's purchase?
4. What are the IT systems that B Vietnam's Purchasing department has adopted and how have you been utilizing them? Are there any constraints when using them?
5. How much time do you spend on manual work (paperwork, searching for supplier, prices on the internet, emailing...) instead of using the help of adopted system?
6. What are the general challenges in your daily job?
7. Do you think AI is appropriate for your product category(ies)? How do you think AI can help you overcome the mentioned difficulties?