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by Denny Trias Utomo

Research Article

Computer and Information Science

PRELIMINARY STUDY OF WEB BASED DECISION SUPPORT SYSTEM TO SELECT MANUFACTURING INDUSTRY SUPPLIERS

基于网页的决策支持系统选择制造行业供应商的初步研究

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Abstract

Industry 4.0 is an integration between automation and manufacturing industry which requires the use of information technology to implement it. In the operational management framework, there is a supply chain management function that is strongly influenced by quality suppliers. Because choosing a quality new supplier is not an easy thing, we need a reliable application tool and utilizing web-based artificial intelligence technology for the selection of suppliers in the manufacturing industry. The selection of new suppliers is a complex problem because it involves multiple criteria, therefore it is necessary to make a decision support system that is able to complete supplier selection properly. Although the selection of suppliers in the manufacturing industry is not new, in the era of Industry 4.0, a decision support system that is used to choose an absolute supplier based online that must be accessible via the web or mobile application. Therefore the writer's idea in this paper is very relevant to be implemented in the manufacturing industry in all fields in the industrial era 4.0.

摘要 工业 4.0 是自动化和制造业之间的集成，需要使用信息技术来实现它。在运营管理框架中，有一个供应链管理功能，该功能受优质供应商的强烈影响。由于选择优质的新供应商并非易事，因此我们需要可靠的应用工具，并利用基于网页的人工智能技术来选择制造业中的供应商。选择新供应商是一个复杂的问题，因为它涉及多个标准，因此有必要建立一个能够正确完成供应商选择的决策支持系统。尽管在制造业中选择供应商并不是什么新鲜事，但是在工业 4.0 时代，决策
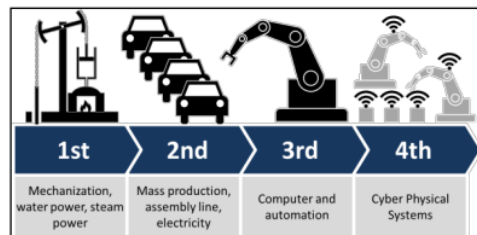
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支持系统用于选择基于绝对在线的供应商，该供应商必须可以通过网页或移动应用程序进行访问。因此，本文的作者的想法与在工业时代 4.0 的各个领域的制造业中实施非常相关。 **关键词:**

工业 4.0，供应链管理，决策支持系统

I. INTRODUCTION

In Industry 4.0 industry players integrate computer networks and communicate with each other through internet networks which, finally, with certain intelligence methods embedded in applications in the form of intelligent knowledge bases, can finally make decisions without human

1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Cyber Physical Systems

involvement [22]. The combination of physical cyber systems, the Internet of Things (IoT), and the Internet of Systems makes Industry 4.0 possible and makes smart factories a reality [1].

Figure 1. Industrial revolution timeline [1]

In Indonesia, the development of Industry 4.0 was strongly encouraged by the Ministry of Industry. Industry Minister Airlangga Hartarto said that for Indonesia to compete with other countries in the industry, Indonesia must also follow the trend [2].

Transformation of the 4.0 Industrial Revolution in the logistics of the manufacturing industry, starting with the integration of production and logistics processes with the appropriate information technology system. This includes exchanging product and production data within the company, as well as with customers and suppliers. According to the Cambridge dictionary, the definition of a supplier is a company, person, etc. who provides things that people want or need, especially during the production process over a long period of time [3].

Suppliers in Industry 4.0, in particular, will benefit from the exchange of design and supplychain data. Communication throughout the production process will be (close to) real time among humans, machines, parts and products. The system that is currently employed will develop into a hierarchical and tiered network with an open and standard interface. Data will be stored in the cloud to accurately increase availability. This will allow more flexibility when reacting to changes (both expected and unexpected) in the production process [4].

In the 4.0 Industrial Revolution, there are demands for inventory management to be more global. Because Industry 4.0 is an integration of the economy with information technology, it will create a process of flow of goods, services, investment and capital, entering from one region to another with a very high level of competition. Thus, it requires a policy of truly competitive local products that are valuable and highly competitive in order to be able to compete

with similar products from other countries (Anindhitya, n.d.). In relation to inventory management, in the industrial world in the Industrial 4.0 era, the most influential things were suppliers.

Still related to the 4.0 Industrial Revolution, choosing suppliers who can fulfill raw material orders that are in line with company industry standards in the long term is absolutely vital. These activities are categorized as strategic activities, because the role of suppliers will also be instrumental in determining the success of the company. If the raw material provided by the supplier are of poor quality, this will also affect the quality of the product produced, so productivity decreases [5], [6], [7], [8], [9], [10], [11], [12]. The accuracy of supplier selection greatly affects the cost efficiency [5], [9]. The right supply of raw materials guarantees a high quality product. A good supply of raw materials will result in an increase in process efficiency so that the company's operating costs can be reduced, and affect the increase in marketing, which results in increasing company profits. If the supplier cannot provide the raw materials according to the company's requirements, then it is certain that the production schedule will be disrupted [13].

Supplier selection, in general, is a multicriteria issue where each criterion has different interests, and the information about them is not precisely known. In this case, the selection of suppliers based on low-price offers is no longer efficient. To get maximum supply chain performance, it must combine other criteria that are relevant to the company's objectives [14].

The selection of new suppliers who have never been partners with companies is a more complex problem, because data is not yet available, and supplier performance is unknown. To choose a new supplier, you cannot use assumptions; it must be based on empirical data that can be accounted for, because it greatly affects production performance [23]. This is not the case with the selection of old suppliers who had been collaborating with the company. Business capability data, track records and other performance indicators are already in the company's database, making it easier to choose and evaluate suppliers who will become partners with the company. Table 1 shows a comparison of the selection of new suppliers and old suppliers [15].

Table 1.
Comparison of selection of old suppliers with new suppliers

Item	Old supplier	New supplier
Supplier track record	Is known	Unknown
Management capability	Is known	Unknown
Price	Is known	Unknown
Delivery performance	Is known	Unknown
Environmental awareness	Is known	Unknown
Service	Is known	Unknown
Flexibility	Is known	Unknown
Technical ability	Is known	Unknown
Innovative	Is known	Unknown
Management approach	Is known	Unknown
Geographical location	Is known	Unknown

Supplier selection is classified as a semistructured problem, where some of these problems are sufficiently structured to be solved by computers (calculation of criteria, calculation of efficiency, etc.) and some require a decision from the manager (selection of evaluation methods, selection of criteria, inputting values, etc.) [16]. The process of selecting suppliers with various criteria can be completed by a computer system that is able to interact with decision makers. The system is a decision support system (DSS) for supplier selection [17].

Based on research that has been done, no one has implemented a decision support system on web-based online media called OnlineDSS.

DSS Online is a decision support system which is a web-based software program. Users access the website then enter their company data to be analyzed. Results are immediately available and updated interactively using web media. Table 2 illustrates the comparison of conventional DSS to online DSS.

Table 2.
Comparison of conventional DSS with DSS Online

Item	Conventional DSS	Online DSS
Speed of decision making	The results are only known after the data recapitulation by the company	Instantly the results are known after the data is filled out completely by the

	supplier	
The accuracy of decision making	Depending on the supplier that fills in supporting data and recapitulation of data contained by the company in the Decision Support System	It depends on the accuracy of the data that is filled in by the supplier only
Working hours of decision making activities	Active according to company working hours	Active for 24 hours non-stop

that can be accessed 24 hours a day in order to welcome the industrial era 4.0.

Based on the description above, this paper proposes a new method to select suppliers online that aims to improve the performance of decision making that already exists.

II. LITERATURE REVIEW

Researchers have written several papers on supplier selection using decision support systems, but no one has published research regarding decision support systems for choosing an online supplier, even though online supplier selection is indispensable in Industry 4.0.

Research to date shows that the selection of suppliers often involves very complicated criteria [14]; therefore, it's necessary to first record all data into a supplier database in accordance with the individual requirements of the company that is selecting a supplier. Kusiak [18] wrote that supplier selection is based on: 1) customer performance quality rating, 2) delivery performance quality rating, 3) total lead time, 4) last sales price, and 5) engineering/design service support.

Supplier databases are used as part of larger decision support systems that have been used by the business world for many years in relation to making strategic corporate decisions. This paper will focus on applying decision support systems to choosing the right online supplier. The decision support system is "filled" with an artificial intelligence algorithm to increase the sophistication of the system itself. Artificial intelligence is a study of problem-solving [19].

Currently being developed by the author is a web-based online supplier selection model

III. METHODS

A. Time and Place

This paper was written from December 2018 to August 2019 in the Mechanical Engineering Study Program, Faculty of Engineering,
Universitas Brawijaya, and the Computing and Information Systems Laboratory of the Department of Information Technology, State Polytechnic, Jember.

B. Materials and Tools
The tools used in this research are:
1. Web Server Apache
2. Lenovo Thinkpad L440 laptop
3. EPSON L-210 printer, HP Deskjet 2130
4. External hard drive: 1TB, 500GB, 250GB
5. 100MBps internet connection

C. Research Methods
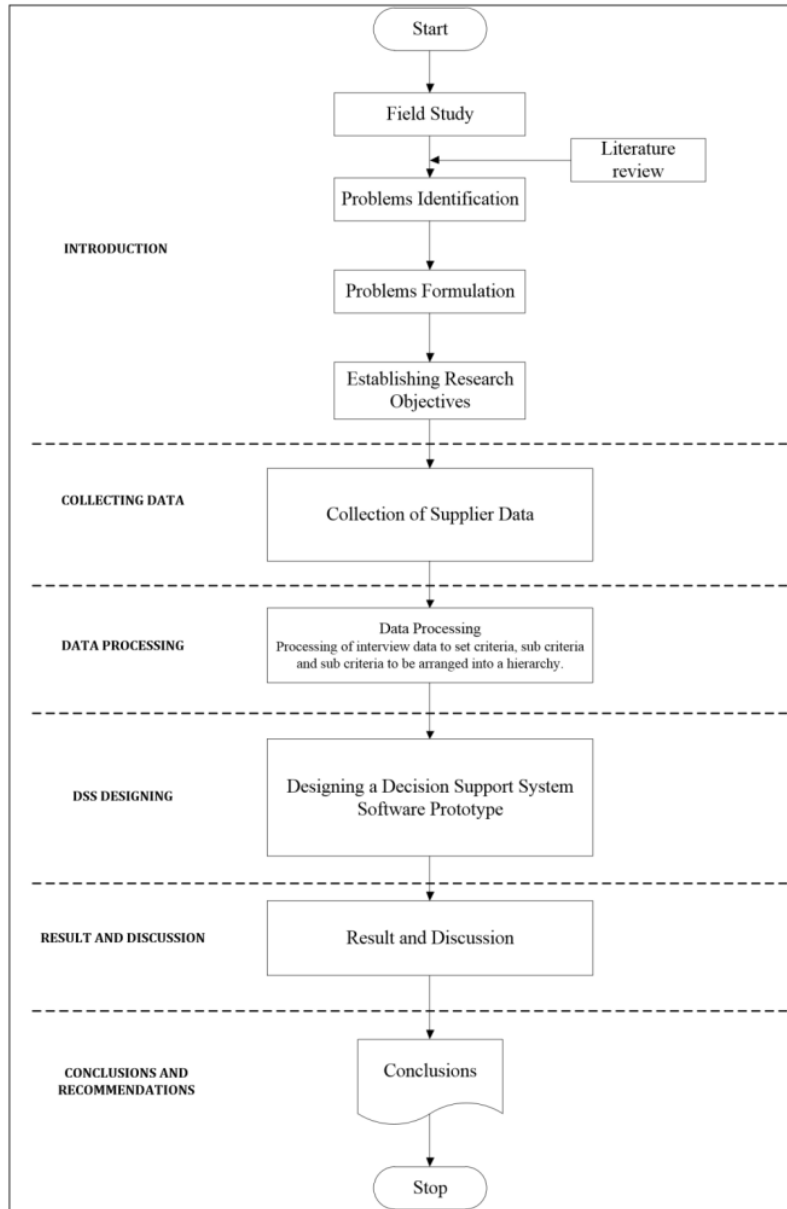
Figure 2. Research methods

Figure 2 is a flow chart of the stages of
the research conducted.

The following is an explanation of Figure 2 starting from the preliminary stages, data collection, system design, and drawing conclusions made by the author in conducting this research are as follows:

1) The Preliminary Stage

The preliminary stages carried out in this research are field studies, literature studies, problem identification, problem formulation, and determination of research objectives. The following is an explanation of each activity in the preliminary stage:

a) Field Study

The field studies conducted in this research are observation activities to identify and reveal the facts that exist in more depth. In this research, a field study was conducted by observing the supplier selection decision-making system.

b) Literature Review

A literature study aims to find information to support the research conducted. Literature study used to support this research comes from journals, textbooks, research reports, the internet, and other literature relating to supplier selection and also the FAHP method.

c) Identification of Problems To know and understand the problem, the initial step that must be done is to identify variables that affect the supplier selection system in the company.

d) Formulation of the Problem After identification of the problem then the problem formulation is then carried out. In the formulation of the problem, researchers must formulate what problems will be examined so that it can simplify the research process.

e) Determination of Research Objectives Goal setting is intended so that researchers can focus on the problem to be studied, so that research can be done systematically and not deviate from the problem to be studied. In addition, the purpose of the research is intended to measure the success of the research conducted by researchers.

2) Data Collection Stage

Data collection is the recording of things/information/characteristics of some or all elements of the population that support and support research. Data collected in this study are as follows:

a) Supplier Data

Data were collected through observation, interviews, and documentation as follows:

b) Interview

This is a method where data are obtained by asking questions directly when the company conducts an activity.

c) Observation

This is a method of obtaining data by making direct observations of the actual situation in the company.

d) Questionnaire

This is a method of giving questions to other people who respond via questionnaires.

e) Archive / Documentation This is a method of obtaining data by studying company documents in the form of project activity reports.

3) Data Processing Stage

After data collection, the next step is data processing. The data from the interviews and discussions relating to any supplier selection criteria were used to establish criteria, subcriteria, and sub-sub-criteria in the preparation of the hierarchy.

4) Prototype Design of Software Decision Support System (DSS) Supplier Selection

This stage is the design of components of the DSS using the prototyping method. The details of these components will be explained in the following:
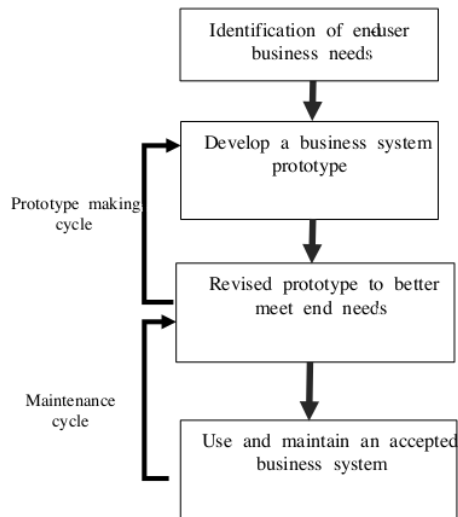
Figure 3. Prototyping cycle

5) System Requirements Analysis

The development of information systems requires investigation and analysis of the reasons for ideas or ideas to build and develop information systems. The analysis was carried out to identify the various components used by the current system, including hardware, software, networks, and human resources.

The analysis also documents the activities of the information system, including input, processing, output, storage, and control.

Next, one must conduct a feasibility study to formulate the information needed by the end-user as well as the resource requirements, costs, benefits, and feasibility of the proposed project.

System requirements analysis, as part of the initial study, aims to identify the problems and specific needs of the system. System-specific requirements are specifications of the things the system will do when implemented.

System requirements analysis must define specific system requirements, including:
- System input required (input)
- Output generated (output)
- Operations performed (process) ▯ Data source handled
- Control (control).

The system-requirements analysis phase requires an evaluation to assess the system's ability by defining what the system should be able to do and, then, determining the criteria that the system must meet. The criteria that must be met include the achievement of objectives, speed, cost, quality of information produced, efficiency, accuracy, validity, and reliability.

6) System Design

System analysis describes what the system must do to meet user-information needs. The system design determines how the system meets these objectives. The system design consists of design activities that produce functional specifications. It can be seen as interface, data, and process design with the aim of producing specifications that match the product, userinterface method, database structure, and processing and control procedures. The system design will produce a prototype software package. A good product should include seven parts:
- Quick and easy menu features.
- Easy-to-print reports.
- A data dictionary that stores information in each field, including the length of the field, the editing in each report, and the format of the field used.
- A database with the optimal format and key record.
- The display of online queries of the data stored in the databases.
- A simple structure with a programming language that allows users to do special processing, time events, automated procedures, and more.

7) System Testing

The prototype software package is tested, implemented, evaluated, and modified repeatedly until it is acceptable to the user. System testing aims to find errors that occur in the system and make system revisions. This stage is important to ensure that the system is error free.

According to Pressman [24], system testing consists of:
- Unit testing to test individual components independently, without other system components, to guarantee the correct operating system
- Module testing consisting of interconnected components
- Testing sub-systems consisting of several modules that have been integrated
- Testing the system to find errors resulting from interactions between subsystems with their interfaces and validating functional and non-functional requirements

- Acceptance testing with data entered by the user and not a simulation data test
- Documentation in the form of recording each step of the work from the beginning to the end of making the program.

Testing web-based information systems can use traditional software testing techniques and methods. Web-application testing includes link, browser, usability, load, voltage, and malar testing.

One measurement model that has been translated into several different languages and does not show significant differences in measurement results is End User Computing (EUC) Satisfaction. This model emphasizes user satisfaction with the technological aspects, including content, accuracy, format, time, and ease of use of the system.

8) Implementation

After the prototype has been received, the implementation of a system that is ready to operate and the learning process for that new system occurs, including a comparison with the old system, a technical and evaluation, as well as evaluations of user interaction, systems, and information technology. *9) Results and Discussion*

Conduct a discussion of the results of making an application and, then, an analysis of the applications that have been completed.

10)   Conclusions and Suggestions

Making conclusions and suggestions are the final steps of the research process. Conclusions can be used as a basis for answering the objectives of the study. Suggestions are an input for the object under study.

IV. DISCUSSION

In this part of the discussion. The explanation of this framework is expected to clarify the position of the research to be conducted.

The supplier-selection system is determined by the following criteria [18]:
1) Management ability
2) Price
3) Environmental awareness
4) Shipping performance
5) Service
6) Flexibility
7) Technical ability
8) Innovation
9) Management approach 10) Geographical location.

This criterion is an indicator of supplier selection. Supplier scores are based on an assessment of each criterion.

A. Problem Analysis

A company in the manufacturing industry has a material supplier in the purchasing department. Suppliers of these materials are numerous and vary in quality and their track records. It is simple to determine the track record for longstanding suppliers using the database in the existing Management Information System. However, for suppliers who have never supplied raw materials to the company, there is no track record in this database.

The company wants to evaluate the quality of these suppliers to ensure regularity in the supply of raw materials for production so that the production flow runs smoothly. The problem that must be resolved is how to select suppliers whose capabilities meet the standards set by the company.

B. New-Supplier Selection Concept

Industry 4.0 is the fourth generation in the development of industrial technology. The First Industrial Revolution began with the discovery of the principle of steam power by Heron of Alexandria in AD 100. It was later refined by James Watt in 1769 [20] — his technology is still in use today. In 1866, Werner von Siemens [21] transferred the principle of a steam engine to an electric generator. This breakthrough made energy transportable and paved the way for the types of machines that ran on electric motors during the Second Industrial Revolution.

The second industrial revolution is marked by perfecting production processes. In Cincinnati in 1870, Henry Ford, Jr. [2] introduced the principle of production assembly lines into the world of cars—which at the time were still made by hand.

The first Ford was launched from an assembly line in 1913, and this new form of organization. It was during this period that the assembly line was found in mass production.

The third industrial revolution is marked by the introduction of computer use and robotic automation. The first flip-flop circuit laid the foundation in 1958 for a big electronic leap forward. Only three years later, the first numerical control device appeared on the market. In 1973, KUKA Robotics launched the first robot with six axes, a step that helped advance automation in Germany and around the world.

Upon entering industry 4.0, there is a fundamental problem if digitalization is carried out. This is specifically in relation to the selection of suppliers from other countries entering Indonesia, considering that technical data is not yet available and that other countries' cultures are different from Indonesia's. Most of the new suppliers that enter Indonesia do not have a track record in company databases. Therefore, it is difficult to choose suppliers that fit a given company's criteria.

The selection of suppliers cannot be separated from initial data availability. For new suppliers who have not yet supplied to any companies, online registration is required. For the first stage, a company announces its need for suppliers. During the second stage, the company is sent documents regarding requirements for registration while a supplier registers their data via email. During the third stage, the company accepts the supplier's registration and provides a link for the supplier to fill in the form. The fourth stage consists of the company checking the completeness of supporting data and storing them in the database. Finally, the data stored in the database is processed by the DSS to generate a proper supplier order.

The DSS is a measuring tool used to select new suppliers based on both technical and cultural criteria. It works by entering score data based on technical criteria. The score data is managed using the Fuzzy Analytical Hierarchycal Process (FAHP) method in order to rank suppliers.

V. Conclusion

Manufacturing supplier selection is a complex problem because it involves multiple criteria. Therefore, a DSS that can complete supplier selection will need to be made.

Although the selection of suppliers in the manufacturing industry is not a new process, in the era of industry 4.0, a DSS that is used to choose an internet-based supplier must be accessible via the web or Android. Therefore, the idea in this author's paper is very relevant to the implementation of industry 4.0 in the manufacturing sector.

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