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Decision Support System Classification And Its Application in Manufacturing Sector: A Review

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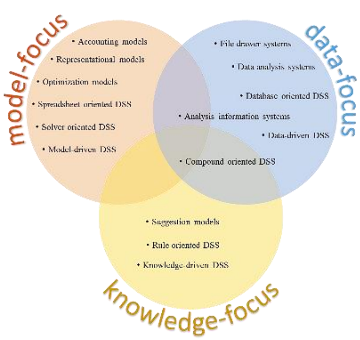
Graphical abstract



Abstract

The purpose of this paper is to review decision support system application trend in manufacturing sector. Following the introduction of decision support system, the paper has discussed the application of decision support system in manufacturing sector and identifies the trend in term of decision support system types and their application types. In year 2011 until 2015, the most preferred decision support system were developed by using the model application. It also been found that, most of the developed decision support system are used to support evaluation activities in manufacturing operations. This review provides research trend on decision support system for the recent five years (2011 -2015) in the context of decision support system application in manufacturing industry.

Keywords: Decision support system, DSS application, DSS types, DSS trend, Manufacturing

Abstrak

Kajian ini adalah bertujuan untuk mengulas trend aplikasi sistem pendukung keputusan di dalam sektor pembuatan. Dimulai dengan pengenalan mengenai sistem pendukung keputusan, kajian ini telah membincangkan aplikasi sistem pendukung keputusan dalam sektor pembuatan dan mengenalpasti trend jenis sistem pendukung keputusan dan juga jenis aplikasi sistem pendukung keputusan. Antara 2011 dan 2015, sistem pendukung keputusan yang dibangunkan menggunakan aplikasi model adalah yang paling mendapat perhatian dan kebanyakan sistem pendukung keputusan digunakan untuk menyokong aktiviti-aktiviti penilaian dalam operasi pengeluaran. Kajian ini memaparkan trend kajian mengenai aplikasi sistem pendukung keputusan dalam industri pembuatan dari tahun 2011 hingga 2015.

Kata kunci: Sistem pendukung keputusan, Aplikasi DSS, Jenis DSS, DSS trend, Pembuatan

1.0 INTRODUCTION

Decision, as defined in the Oxford Dictionaries, is "a conclusion or resolution reached after consideration". In general, the complexities and uncertainties in decision making process has marked the importance of research in decision support system [1]. One of the advantages from the development of computer engineering field is the development of system which can support the decision making process. In 1976, decision support systems (DSS) was symbolized as a fundamental idea of the use of information system and analytic tools during decision making process [2], which now has become a mainstream. There are two areas in which DSS research has evolved; namely the theoretical studies and the technical work. The theoretical studies on organizational decision making was conducted in the late 1950s at the Carnegie Institute of Technology while the technical work was carried out in 1960s at MIT [3], [4].

Decision making process has become one of the daily challenges faced by the manufacturing sector due to various operational controls. A computerized system which supports the decision making process is now enabled by the advancement in computer technologies development. Therefore, decision support systems play a big role and becoming an important element in industrial investment decision activities [5] and contribute in supporting decision makers for all levels in manufacturing management.

Shim *et al.* [4] stated that DSS has been developed expressively since 1970s. Up to 2015, there are many researches done in decision support system area and this includes a survey done to study DSS area of application in general [6]. However, there is yet a study to be done to capture the trend of DSS application in manufacturing sector. Hence, the objective of this paper is to focus on the applications of DSS in manufacturing sector in order to obtain the trend in the types of DSS and its application.

This paper has been organized into a few sections. Section 2 explains the research method used in this review. Section 3 and Section 4 review on the decision support system in general and its application in manufacturing sector respectively. A conclusion along with suggestions for future research are explained in Section 5.

2.0 METHODOLOGY

In this paper, the literature study on DSS application was carried out in two stages. At the first stage, the collection of relevant research articles on decision support system was done based on following criteria: (i) The selection for research articles was limited to Scopus indexed journal, (ii) The focus was on DSS application in manufacturing sector, (iii) The time frame had been set from 2011 to 2015, in order to capture and study DSS application in the recent five years, (iv) The keywords used for the literature browsing were "decision support system", "manufacturing", and "DSS". The importance of setting up these criteria prior to the study was to give an overview of this research's extent and boundary [7]. As a result, a total of 48 articles which meet the aforementioned criteria were carefully selected. It was important to identify and select the relevant articles carefully in order to ensure the discovered information and knowledge were rigorous and accurate [8].

At the second stage, all the selected articles from the first stage were reviewed and analyzed. In this regard, the information gathered has been grouped into three categories: (i) The types of DSS, (ii) The classification of DSS, and (iii) The types of DSS application in the manufacturing sector. Based on the gathered information, an analysis and a review about DSS application trend in manufacturing sector were carried out. Finally, a comprehensive conclusion was drawn along with suggestions for future research on DSS.

3.0 DECISION SUPPORT SYSTEM

3.1 What is Decision Support System?

The decision support system (DSS) is known by its purpose, which is to support the decision maker in decision making process. It has been more than half decade since DSS was first introduced in the middle of 1960s [9]. DSS has no specific definition as different researchers have proposed different definitions [10]. Power [9] defined DSS as a computer application that improves individual or group's capability in decision making process. The said ability is supported by a class of computerized information system [9], [11]. Raheja and Mahajan [12] defined DSS as a single powerful system which supports three types of decision making process which are the structured, semi-structured, and unstructured problem, and the system is a combination of data, sophisticated analytical tools, and a user friendly software. DSS also has been defined as a system that enhances quality and effectiveness of the provided resolutions or improving the process and output of the decision making process [13], [14]. On another perspective, Fang [15] defined DSS as an application of various data and models to Human-machine interface (HMI) in order to assist decision makers at each level to achieve a scientific decision. Complementary to this, Bukharov and Bogolyubov [10] had stated that DSS as a computer-based information system designed to support in building complicated decisions through a more profound and focused analysis of the focus area.

Aside from DSS definition, Marakas [5], Turban *et al.* [16] and Janakiraman and Surakesi [17] had highlighted the DSS characteristics. DSS focuses more on the effectiveness rather than the efficiency of decision making process, interactive and user-friendly, provides decision support to all level of management, ease of development, adaptable and flexible, can be either standalone system, integrated system, or web-based system. DSS supports individual, group, and team-based decision making, supports multiple independent or interdependent decision. In addition, DSS is capable of carrying out "What-if" analysis. DSS is incorporated with various mathematical, statistical, and operation research models. From the entire stated characteristics, the most important characteristic of DSS is that the system is intended to provide supports for decision making process, and not to replace the decision maker. Regardless of being highly advanced, the system cannot support the decision makers in the emotional aspect.

3.2 DSS Components

DSS is composed by three basic components which are; (i) data management subsystem (DMS), (ii) model base management subsystem (MBMS), and (iii) dialog generation and management subsystem (DGMS) or known as user interface subsystem [17]–[20]. Kersten *et al.* [21] added knowledge-based management subsystem as another component for DSS. Figure 1 shows the illustrative picture on DSS components.

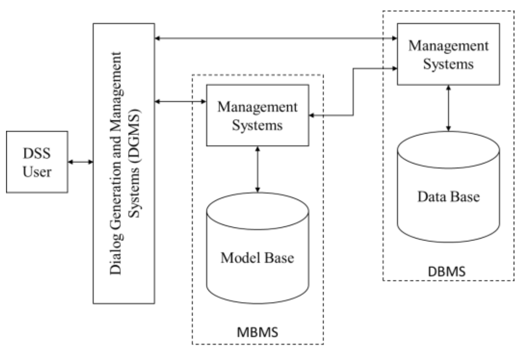


Figure 1 DSS Components [18]

According to Janakiraman and Sarukesi [17], data management subsystems keep data that are needed for decision making process, managed by a computer software called DBMS. It allows users to insert or delete, modify, and query the data.

MBMS stores other necessary models such as financial, statistical, management science, or quantitative models that are required for decision making analysis [16]. Similar to DBMS, MBMS also supports the users by enabling the development, execution, and management of models. Janakiraman and Sarukesi [17] mentioned MBMS as an interface to the database, which means that MBMS transforms data from DBMS into useful information for decision making process. According to Sage [18], the difference between management information systems (MIS) and decision support system (DSS) is that MBMS is not available in MIS, in such a way that if MBMS is added into MIS, then the system will be called as DSS.

On the other hand, the user interface subsystem or known as DGMS, is a system that enables the communication between users and DSS. Janakiraman and Sarukesi [17] highlighted some major activities for DGMS such as; (i) provides menus and icons that contribute to effective communication between DSS and the users, (ii) provides required on-line context sensitive help to various users, (iii) transforms queries from user so it can be identified and executed by other subsystems, and (iv) keeps track of the performed tasks.

3.3 DSS Classification

As the definition, DSS does not have a standard, specific or globally accepted classification. As shown in Figure 2, Alter [22] proposed seven types of DSS; (i) file drawer systems, (ii) data analysis systems, (iii) analysis information systems, (iv) accounting models, (v) representational models, (vi) optimization models, and (vii) suggestion models. These seven types of DSS were classified based on "the degree of action implication of system outputs" [16]. All seven classified DSS then can be clustered into two types; the data-oriented DSS and the model-oriented DSS.

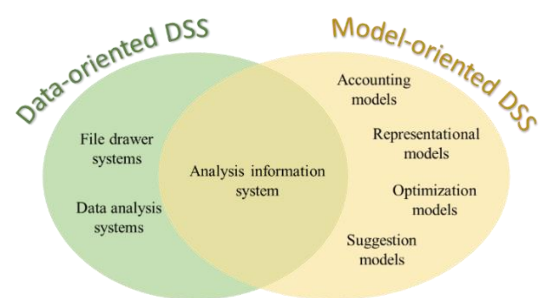


Figure 2 Classification of DSS

In this regard, based on its focused application, analysis information system is a common subset shared by both data-oriented DSS and model-oriented DSS. File drawer systems and data analysis systems are present in the data-oriented DSS, whilst the rest of DSS types are present in the model-oriented DSS. Turban *et al.* [16] characterized the types of DSS into operation type and task type as shown in Table 1.

Later, Holsapple and Whinston classified DSS into six types; (i) text oriented DSS, (ii) database oriented DSS, (iii) spreadsheet oriented DSS, (iv) solver oriented DSS, and (v) rule oriented DSS, meanwhile (vi) compound oriented DSS referred as a combination of any types stated above [23] as depicted in Figure 3.

Table 1 Characteristic of Alter's DSS [16]

Category	Operation type	Task type
File drawer systems	Access data item	Operational
Data analysis systems	Particular analysis of data file	Operational analysis
Analysis information systems	Particular analysis including multiple databases and small models	Analysis, Planning
Accounting models	Prediction in term of accounting basic on future output through standard calculations	Planning, Budgeting
Representational models	Prediction on consequences of particular conducts	Planning, Budgeting
Optimization models	Optimal solution computation for a combination problem	Planning, Resources allocation
Suggestion models	Calculations performed which develop suggestion on decision	Operational

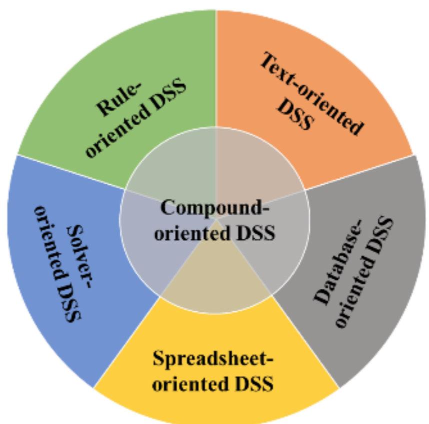


Figure 3 Holsapple and Whinston's DSS Classification

Text-oriented DSS supports its user by electronically keeping the track of information that are represented in text forms that could contribute in decision making process [24]. Thus, users can create, revise, and review documents electronically. For database-oriented DSS, it consists of information organized in the database. As the information is handled in regional database, it allows users to access information needed in high volume, descriptive, and rigidly structured [16]. In contrary, spreadsheet-oriented DSS supports its user by enabling the features of creating, viewing, and modifying the procedural knowledge [24] and users are also allowed to develop the models to do the DSS analysis [16]. Solver-oriented DSS is a system where one or more solvers are equipped as each solver can be used to solve a particular type of problem. Solver-oriented DSS supports the decision makers by solving related problems in other areas such as financial, economic, forecasting, planning, statistical, and optimization. The rule-oriented DSS consists of representing and processing the rules and supports the users by suggesting appropriate solution. It also stated that rule-oriented DSS is evolved within artificial intelligent field, therefore giving computer the ability to manage reasoning knowledge.

Power [25] has classified the DSS into five types; (i) data-driven DSS, (ii) model-driven DSS, (iii) document-driven DSS, (iv) communication-driven DSS, and (v) knowledge-driven DSS. The description on each classification of DSS is shown in Table 2.

Table 2 Classification of DSS by [25]

Classification	Description
Data-driven	This system focuses on large database access and manipulation. The large database contains time-series and structured data either from internal or from external source [25]. Data-driven DSS support decision maker thru analysis on large amounts of data [26].
Model-driven	Each of developed model-driven DSS has specific purpose as different model used for different set of problems. Model-driven DSS focuses on model access and manipulation. Analytical model such as accounting and financial models, representational models, and optimization models are the major component of this kind of DSS. Model-driven DSS does not need a big database, as it requires data and parameters given by the users.
Document-driven	This system supports decision makers by supporting document and web pages retrieval and management.
Communication-driven	Enhances user capabilities by supporting communication between people working on the same task. Commonly used with other type of DSS [26].
Knowledge-driven	Knowledge-driven DSS provides support to decision makers by suggesting appropriate solution for a problem through its problem solving expertise. Integration with artificial intelligence enables the problem-solving capabilities for this type of DSS. This system uses inference engines (heuristic model) in order to process the rules.

Based on the literature study, it is concluded that there is a possible relationship among the aforementioned types of DSS proposed by Alter [22], Holsapple and Whinston [23] and Power [25]. Figure 4 presents the relationship of DSS types in three different focuses; (i) Model-focus, (ii) Data-focus, and (iii)

Knowledge-focus. The Model-focus refers to DSS developed focuses on the use of large database for simple analysis purposes. The Data-focus refers to DSS developed focuses on the application of models to solve a certain domain of problems such as optimization, financial, and mathematical models. The Knowledge-focus refers to DSS developed with the integration of artificial intelligence which enables the DSS to have a human-like capabilities in solving a certain domain of problems.

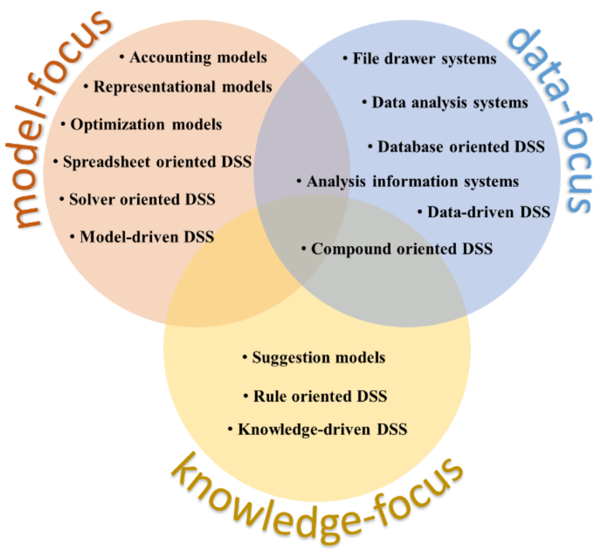


Figure 4 DSS classification based on focus area

The document-driven DSS and the communication-driven DSS were excluded from Figure 4 due to their description which does not contain the same focus development with the other types of DSS. The document-driven DSS supports the document retrieval, while the communication-driven DSS supports the communication activities between people who are working on a same task. However, from the author's view, both document-driven and communication-driven DSS can be included in either the model-focus DSS or the knowledge-focus DSS depending on how the system is developed. For example, in retrieving a certain type of documents, artificial intelligence such as artificial neural network, genetic algorithm, or particle swarm optimization is integrated into the DSS. Therefore this DSS can be classified under knowledge-focus DSS.

4.0 DSS IN MANUFACTURING

In this paper, a review on DSS application in manufacturing has been carried out in order to identify the trend of DSS application in the recent five years (2011 until 2015). In this regard, a thorough literature study has been done on relevant articles of DSS application based on the classification of DSS proposed by Alter [22], Holsapple and Whinston [23] and Power [25]. The review focuses on two aspects (i) DSS classification, and (ii) DSS application, in the context of manufacturing sector. Table 3 shows the DSS classification and related articles from 2011 to 2015.

Table 3 Research articles on DSS in the context of manufacturing industry in the recent five years (2011until 2015)

DSS Types		Research Articles
Alter (1980)	File drawer systems	*n.a*
	Data analysis systems	*n.a*
	Analysis information systems	[27], [28]
	Accounting models	*n.a*
	Representational models	[29], [30], [31]
	Optimization models	[29], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53]
	Suggestions models	[54], [55], [56], [33], [57], [58], [59], [60], [35], [41], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73], [74], [75]
Holsapple and Whinston (1996)	Text-oriented	*n.a*
	Database-oriented	*n.a*
	Spreadsheets-oriented	[27], [30], [31], [28]
	Solver-oriented	[29], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53]
	Rule-oriented	[54], [55], [56], [33], [57], [58], [59], [60], [35], [41], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73], [74], [75]
	Compound oriented	[33], [35], [41]
Power (2004)	Data-driven	*n.a*
	Model-driven	[29], [32], [33], [34], [35], [36], [37], [38], [27], [39], [40], [41], [42], [43], [44], [30], [31], [45], [46], [47], [48], [49], [50], [51], [52], [28], [53]
	Document-driven	*n.a*
	Communication-driven	*n.a*
	Knowledge-driven	[54], [55], [56], [33], [57], [58], [59], [60], [35], [41], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73], [74], [75]

**n.a: No research articles found for the said DSS types from 2011 to 2015*

Figure 5 indicates the result analysis of the research trend on DSS application based on DSS classification proposed by Alter [22], Holsapple and Whinston [23] and Power [25], and the intersection of all the three classifications. Based on the intersection from the three classifications of DSS, as shown in Figure 5(d), it is found that a total of 24 articles were done based on model-focus DSS, which made up to 49% from all DSS application related research from 2011 to 2015. It is followed by the knowledge-focus DSS which has a total of 21 articles, made up to 44.9%, 4.1% lower than model-focus DSS. A total of 6.1% from the total of DSS application related research from 2011 to 2015 contributed to the combination between model and knowledge focus DSS. Figure 5(a) shows the DSS research trend based on DSS classification proposed by Alter [22]. It shows that the suggestion models DSS has the highest percentage as much as 44.9%, while the lowest is shared by representational model and analysis information systems DSS. Figure 5(b) shows the DSS research trend based on DSS classification proposed by Holsapple and Whinston [23]. It shows the rule-oriented DSS gets more attention at 44.9% than the compound-oriented DSS with the least at only 6.1%. Lastly, Figure 5© shows the DSS research trend based on the DSS classification proposed by Power [25]. The highest percentage research done was based on the types of DSS is the model-driven DSS (49%). Following with 44.9%, knowledge-driven DSS received quite a similar attention from other researchers as well

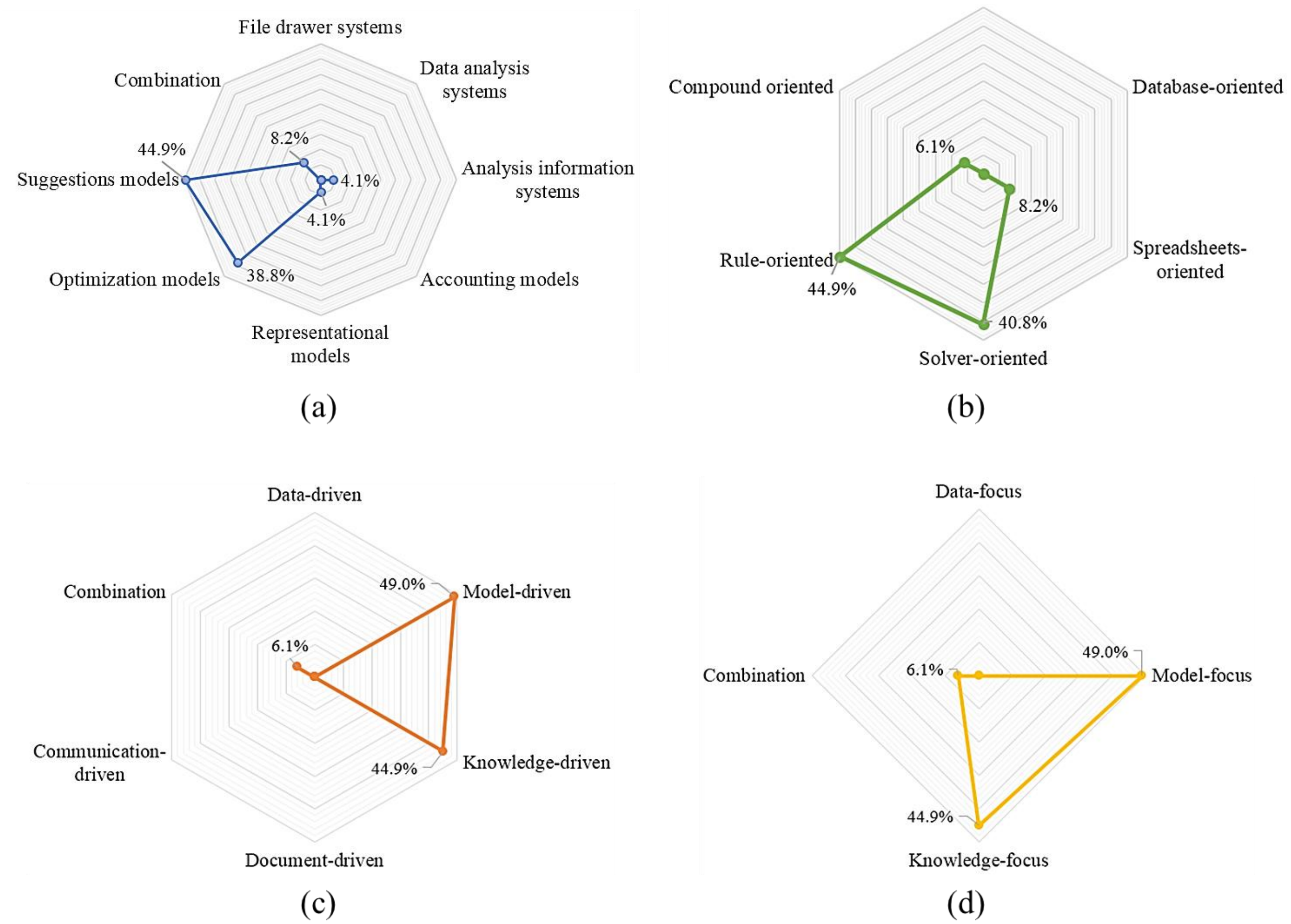


Figure 5 Research trend based on (a) Alter (1980) DSS classification, (b) Holsapple & Whinston (1996) DSS classification, (c) Power (2004) DSS classification, (d) DSS focus-area classification

The results of the literature study found that DSS has been used for many applications such as evaluation, prediction, selection, and optimization purpose. Table 4 shows the areas of DSS application based on the relevant research in the five recent years (2011 until 2015). This study divided DSS applications into two types; (i) single application, and (ii) mixed-application (application with two and more purpose). In total, 75.5% of the reviewed articles contributed to the single-application DSS and the rest contributed to the mixed-application DSS.

Table 4 DSS application and related research articles (2011-2015)

Application		Research Articles	Percentage
Single application	Evaluation	[29], [32], [59], [36], [27], [61], [44], [63], [30], [45], [66], [49], [71], [73], [51], [52], [28]	34.7%
	Estimation/prediction	[42]	2.0%
	Selection	[31], [65], [46], [69], [70], [50]	12.2%
	Scheduling	[37], [48], [68]	6.1%
	Cost optimization	[40], [43]	4.1%
	Operation optimization	[56], [38], [39], [47], [67], [72], [74], [53]	16.3%
Mixed-application	Evaluation + Prediction	[60], [64]	4.1%
	Evaluation + Selection	[55], [33], [58], [41], [62], [75]	12.2%
	Evaluation + Operation optimization	[34]	2.0%
	Evaluation + Prediction + Selection	[54], [57]	4.1%
	Optimization (Cost + Operation + Quality)	[35]	2.0%

Single-application DSS, can be divided into six types of application; (i) evaluation, (ii) prediction, (iii) selection, (iv) scheduling, (v) cost optimization, and (vi) operation optimization. In this regard, evaluation refers to DSS being employed to support the evaluation activities such as evaluating a process, items, and people. According to Adhitya *et al.* [29], DSS has been applied to evaluate the supply chain design in term of economic and environmental impacts. Moosavirad *et al.* [44] used DSS in supply chain evaluation for the impact of outsourcing activity in term of CO2 emission. Another example of DSS application for evaluation is performance evaluation was used to evaluate the operation leanness level [59], [61], [71]. Bosch-Mauchand *et al.* [36] used DSS to evaluate manufacturing process based on its value chain. In addition, Karthik *et al.* [28] used DSS for performance evaluation where DSS is deployed to support the evaluation of carry and forward agents (CFAs). DSS has also been used for evaluating product sustainability and company sustainability [32], [73]. DSS also supports quality assessment [63], for example, it has been deployed in evaluating quality of welding process [27] and quality of EC motor [51]. DSS is also used to support the evaluation of reuse manufacturing system [45], where such DSS was designed in order to support the development of industry specifically in the developing countries. Jenab *et al.* [52] used DSS to evaluate Computer Integrated Manufacturing (CIM) technologies. In term of ergonomics in manufacturing operation, DSS has been implemented as a support in evaluating the effect of prolonged standing at the workplace [66].

DSS has also been used for estimating tasks. Liu *et al.* [42] applied DSS in predicting practicable production lead times of a mold production which supports the quoting mold due date at the customer enquiry stage. Besides prediction, DSS has been utilized to support selection process such as selecting the proper or suitable machine in manufacturing operation. For instance, Aloini *et al*. [65] employed DSS to support the selection of packaging machine while Bahadir and Satoglu [46] used DSS to support the selection of an arm robot. Yurdakul *et al.* [50] used DSS to support the selection of manufacturing process which involved more than one machine application. DSS has also been used for supplier selection. Leng *et al.* [69] and Orji and Wei [70] had applied DSS in supplier selection process but with different selection objectives, which were the beneficial point and the sustainable point respectively. In manufacturing operation, there are times where decision makers have to select an appropriate method or tools in order to improve the operation. For instance, Starzyńska and Hamrol [31] used DSS in selecting appropriate quality tools and techniques (QT&T). In addition, DSS has also been used to support scheduling activity, which are presented by Fu *et al*. [37] , Cevikcan and Durmusoglu [48] and Kocsis *et al*. [68].

Another type of single-application DSS in manufacturing is supports the optimization activities. Rimašauskas and Rimašauskienė [40] had developed a DSS which supports cost optimization task by means of fused deposition modelling technologies aiming towards minimization of manufacturing time. The DSS supports the engineers by enabling them to choose the best solution for manufacturing process. Apart from cost optimization, DSS can also be used to support operation optimization. For instance, Poon *et al.* [56] and Ting *et al.* [72] have proposed DSS for optimizing control over warehouse and logistics management respectively. Poon *et al.* had used DSS in managing warehouse operation to solve stochastic material demand by production operation. Differently, Ting et al. had deployed DSS in logistic management in order to define a decent logistics strategy which can maintain a product's quality and safety. DSS has also been used to support operation optimization in supply chain management. For example, Kristianto *et al*. [38] developed DSS to support the supply chain reconfiguration process. In addition, Boza *et al*. [47] had proposed DSS in a collaborative supply chain environment in order to solve material shortage issue for manufacturers with lack of homogeneity in products (LHP).

DSS has also been designed not only to focus in one single application, but also for multiple application. For example, a DSS developed to perform evaluation and at the same time to support prediction task, selection task, or optimization task. Achanga *et al*. [60]

had developed a DSS that is able to evaluate the current manufacturer performance, in terms of lean readiness and also to predict the relative cost towards the lean implementation in the future. Another example of multiple application of DSS is for the purpose of supporting the evaluation and selection over a few alternatives such as selection of equipment, machinery or software [33], [41], [55], [58], [62], [75]. DSS has been used purposely for evaluation, prediction or estimation task, and selection [54], [57]. They have proposed DSS not only to support the evaluation and selection of machine tools but also have added predictive ability. In this case, the DSS was able to predict the errors of the machine, the alternatives and its process time and at the same time, the system was able to predict the ranking of the alternatives respectively. In a different aspect, Shao *et al.* [34] proposed a DSS which supports the evaluation and operation optimization in term of sustainable practices in manufacturing operation. Another example on mixed application of DSS was presented by Battaïa *et al.* [35] that focuses on quality, operational, and cost optimization where the DSS was developed to assist the user during designing production machining lines in order to achieve quality, productivity, and minimizing the investment cost.

Figure 6(a) and 6(b) depicted the percentage distribution of DSS application in manufacturing industry in the recent five years (2011 until 2015). As can be seen in Figure 6(a), the DSS applied for evaluation activities contributes to the highest percentage (35% of the total number of DSS application) in manufacturing industry compared to other types of DSS application. Overall, the result shows that DSS has been applied more frequent in single-application than mixed-application which is only at 24%. The portion of DSS mixed application is shown in Figure 6(b). As can be seen, DSS mixed application for evaluation and selection contributes to the highest percentage (12%) of the total number of DSS mixed application in the recent five years.

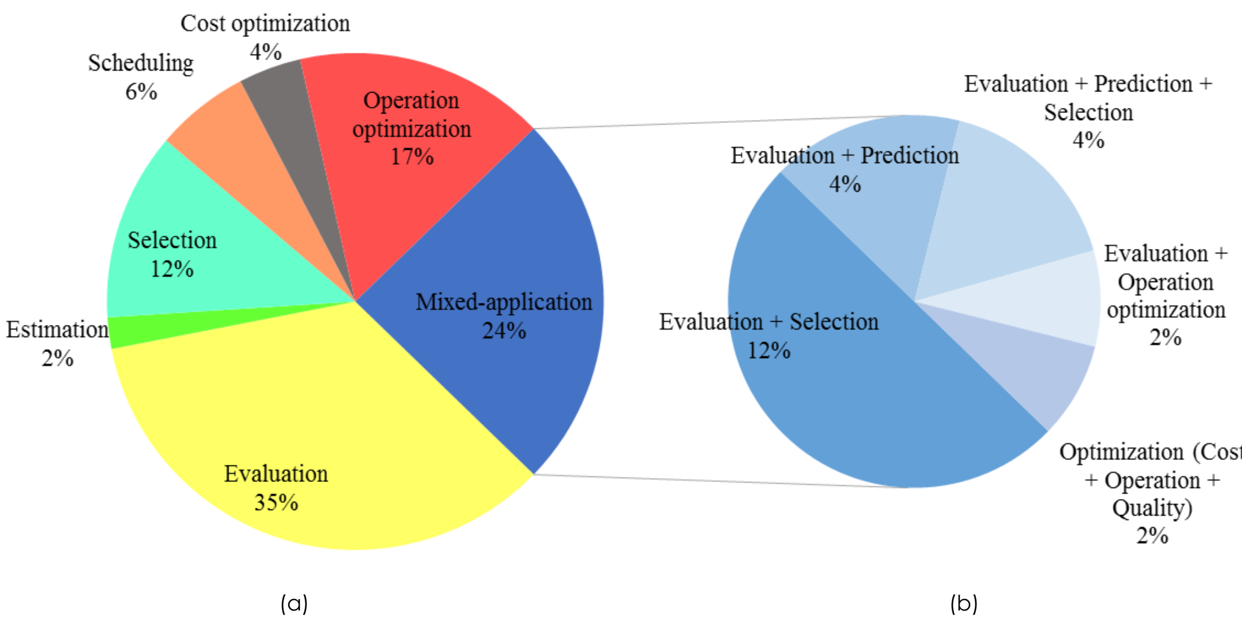


Figure 6 (a) Types of DSS application in manufacturing industry, (b) Types of DSS application in mixed application

5.0 CONCLUSIONS

In summary, this paper discloses the research trend on DSS and its application in manufacturing industry for the recent five years (2011 until 2015). Three classifications of DSS have been clarified based on the reviewed DSS by Alter [22], Holsapple and Whinston [23] and Power [25]. Thus, this paper illustrates the classifications of DSS into three different focuses; (i) data-focus DSS (ii) model-focus DSS, and (iii) knowledge-focus DSS (Figure 4). It is found that compound oriented DSS is related to all the three types of focus DSS while analysis information system belongs to both data focus and model focus DSS. Based on the literature study of DSS and its application in manufacturing industry for the recent five years (2011 until 2015), 49% of the developed DSS is model-focused DSS and closely followed by knowledge-focused DSS. The single-application DSS especially for evaluation is the most being in use by the manufacturing industry. For the mixed-application DSS, evaluation and selection activities have the highest application in manufacturing industry. For future works, a comprehensive study can be conducted to reveal other details on the DSS trend which focuses on tools or methods used to develop DSS in manufacturing industry. Tools such as financial, mathematical, and optimization modelling were being used to develop DSS and some of them were also developed by using artificial intelligence tools such as fuzzy, artificial neural network (ANN), genetic algorithm (GA), and expert system (ES). In addition, another recommendation for future study to be carried out is to comprehensively review DSS application that focuses on specific types of manufacturing sector.

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