Designing a social manufacturing system model based on the internet of things technology

by Andri Arif Kustiawan

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Abstract. As a new form of manufacturing industry, social manufacturing shows the complexity of social-cyber, such that the source of manufacturing services is social. It thus can exacerbate uncertainty and dynamic supply of services. The Cyber-Physical System (CPS) merging with social media produces a social manufacturing and basic theory for future production organization. Three aspects that are the core of social manufacturing are configuration, operation, and management perspectives, which are expected to contribute to the transformation of production modes and social innovation. Social manufacturing is proposed as an innovative manufacturing solution for the future era of product personalization customization. This study aims to develop a conceptual model of an integrated production system based on the internet of things in social manufacturing. The methods used include literature studies, interviews, model design, testing of production system models in the laboratory scope, and analysis of the results of testing production system models. The output of this research is a conceptual model of an integrated production system based on the internet of things in social manufacturing.

Keywords: Social Manufacturing, internet of things, system design, system model

INTRODUCTION

As a new form of manufacturing industry, social manufacturing shows the complexity of social-cyber, such as the social source of manufacturing services [1, 2]. It thus can exacerbate uncertainty and dynamic supply services [3]. The Cyber-Physical System (CPS) merging with social media produces a social manufacturing and basic theory for future production organization [4, 5]. Three aspects at the core of social manufacturing are configuration, operation, and management perspectives, which are expected to transform production modes and social innovation [6]. Social manufacturing is proposed as an innovative solution for the future era of product personalization customization [6, 7]. In addition, social manufacturing is considered to be able to realize the concept of "from mind to product" to meet customer demand, so the challenge for the future is to add applications and the prospect of personalized products and services for customers [8]. The social manufacturing community was formed to meet every customer need by grouping small industries according to the type of resources [9]. Every customer request can be solved together [10]. Product costs and delivery times are indicators for allocating product orders in the social manufacturing community formed [11, 12]. Currently, internet of things (IoT) technology [13] that can connect customers and manufacturers has also been implemented in social manufacturing systems [14]. Development of a social manufacturing system involving SMEs made integrated with the IoT technology [15].

Based on these studies, the design of an integrated production system model in social manufacturing based on IoT technology is carried out. The purpose of this study is to produce a model of a social manufacturing system involving SMEs. Their production processes can be monitored online and in real-time via the internet.

MATERIALS AND METHODS

Materials

The materials used in this research are hardware and software equipment. Hardware is needed to design an internet-based system that uses an Arduino microcontroller, RFID and RFID tags for reading data from product samples, and an ESP 8266 module for connection to the internet. At the same time, the software tools used include Arduino IDE, PHP to create a web-based system display, then ProModel software for simulating social manufacturing system models.

Methods

The data collection method in this study was carried out to obtain data to be analyzed and processed so that it was found what problems exist, and it is hoped that this research can produce solutions to these problems. The methods used in data collection include interviews, literature study, needs analysis, and system design analysis. The data collected in this study used a literature study to explore sources of information through library searches, especially research results published in national and international proceedings/journals. Then make observations, by direct observation of everything that has to do with the object of research and interviews to obtain and dig up information about informants' experiences in production system problems, as shown in flowchart Figure 1.

The data analysis method that will be carried out in this research is model design, model testing, and analysis of the resulting model. The trial model for developing an IoT-based integrated production system in social manufacturing is carried out in the laboratory by simulating the model that has been created. Next, analyze the results related to the social manufacturing model simulation and review the results.

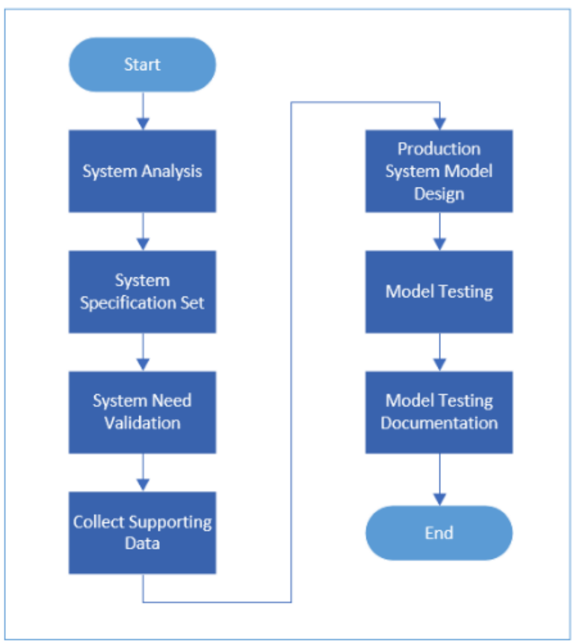


FIGURE 1. System Design Flowchart

RESULTS AND DISCUSSION

The results of the system modelling are presented in Figure 2. Modelling of an integrated production system is designed involving suppliers, 4 (four) Small and Medium Enterprises (SMEs), integrators, and warehouses for product storage and markets.

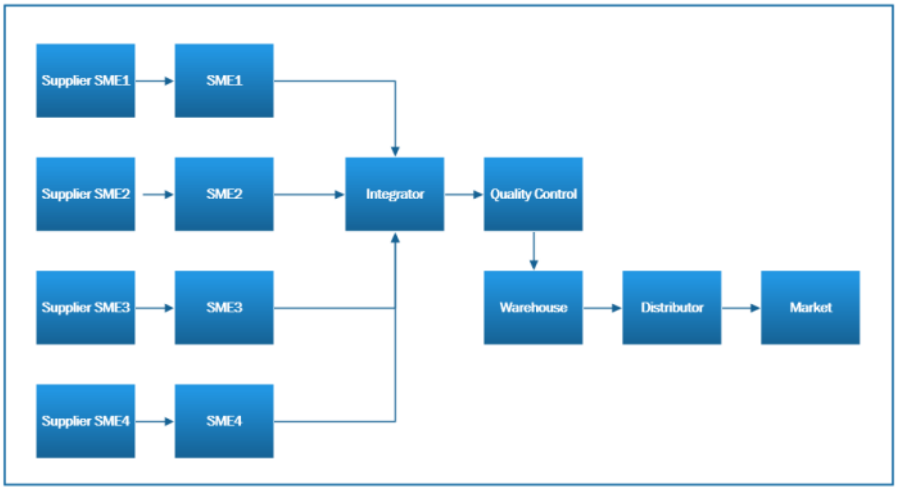
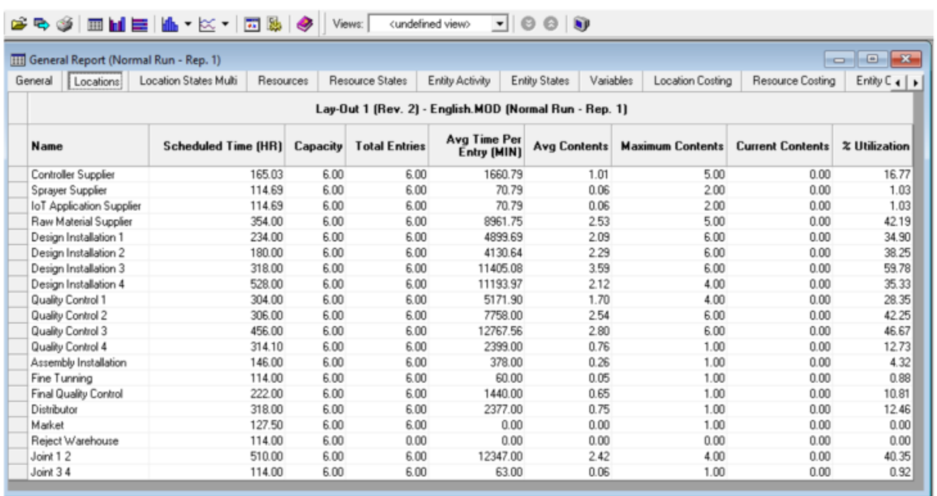


FIGURE 2. System Model

Furthermore, the model is simulated using ProModel software, and the simulation results are presented in Figure 3. The system model involves four SMEs and four quality control processes in each SME located far apart.



General Report (Normal Run - Rep. 1)

Lay-Out 1 (Rev. 2) - English.MOD (Normal Run - Rep. 1)

Name	Scheduled Time (HR)	Capacity	Total Entries	Avg Time Per Entry (MIN)	Avg Contents	Maximum Contents	Current Contents	% Utilization
Controller Supplier	165.03	6.00	6.00	1660.79	1.01	5.00	0.00	16.77
Sprayer Supplier	114.69	6.00	6.00	70.79	0.06	2.00	0.00	1.03
IoT Application Supplier	114.69	6.00	6.00	70.79	0.06	2.00	0.00	1.03
Raw Material Supplier	354.00	6.00	6.00	8961.75	2.53	5.00	0.00	42.19
Design Installation 1	234.00	6.00	6.00	4899.69	2.09	6.00	0.00	34.90
Design Installation 2	180.00	6.00	6.00	4130.64	2.29	6.00	0.00	38.25
Design Installation 3	318.00	6.00	6.00	11405.08	3.59	6.00	0.00	59.78
Design Installation 4	528.00	6.00	6.00	11193.97	2.12	4.00	0.00	35.33
Quality Control 1	304.00	6.00	6.00	5171.90	1.70	4.00	0.00	28.35
Quality Control 2	306.00	6.00	6.00	7758.00	2.54	6.00	0.00	42.25
Quality Control 3	456.00	6.00	6.00	12767.56	2.80	6.00	0.00	46.67
Quality Control 4	314.10	6.00	6.00	2399.00	0.76	1.00	0.00	12.73
Assembly Installation	146.00	6.00	6.00	378.00	0.26	1.00	0.00	4.32
Fine Tunning	114.00	6.00	6.00	60.00	0.05	1.00	0.00	0.88
Final Quality Control	222.00	6.00	6.00	1440.00	0.65	1.00	0.00	10.81
Distributor	318.00	6.00	6.00	2377.00	0.75	1.00	0.00	12.46
Market	127.50	6.00	6.00	0.00	0.00	1.00	0.00	0.00
Reject Warehouse	114.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00
Joint 1 2	510.00	6.00	6.00	12347.00	2.42	4.00	0.00	40.35
Joint 3 4	114.00	6.00	6.00	63.00	0.06	1.00	0.00	0.92

FIGURE 3. Simulation Result

The simulation results for Entity Activity can be seen in Figure 4. Based on the simulation results, it can be seen that for the three entities, Avg Time in System is worth 0.00, with the lowest value being 12107.00 and the highest being 28965.00 in Final Product.

Lay-Out 1 (Rev. 2) - English.MOD (Normal Run - Rep. 1)

Name	Total Exits	Current Qty In System	Avg Time In System (MIN)	Avg Time In Move Logic (MIN)	Avg Time Waiting (MIN)	Avg Time In Operation (MIN)	Avg Time Blocked (MIN)
Controller	6.00	0.00	12107.81	2036.22	2959.90	5760.00	1351.69
Sprayer	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IoT Application	6.00	0.00	24278.00	105.36	5847.82	11520.00	6804.82
Raw Material	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WIP BICO 12	6.00	0.00	24344.00	108.36	6021.81	4380.00	13833.83
WIP BICO 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Product BICO19	6.00	0.00	28965.00	11054.03	6.00	14580.00	3324.97

FIGURE 4. Entity Activity

Furthermore, the Costing simulation shown in Figure 5 contains the Total Cost in Dollars and % Total Cost. Because the cost data is incomplete, so it only appears on the Final Product.

Lay-Out 1 (Rev. 2) - English.MOD (Normal Run - Rep. 1)

Name	Explicit Exits	Total Cost Dollars	% Total Cost
Controller	0.00	0.00	0.00
Sprayer	0.00	0.00	0.00
IoT Application	0.00	0.00	0.00
Raw Material	0.00	0.00	0.00
WIP BICO 12	0.00	0.00	0.00
WIP BICO 34	0.00	0.00	0.00
Final Product BICO19	6.00	6411.46	100.00

FIGURE 5. Costing Simulation Results

The simulation results for Location Utilization in the form of a bar chart are shown in Figure 6. The graph shows that the lowest location utilization is in the Fine-tuning process, while the highest value is in the Design Installation 3 process.

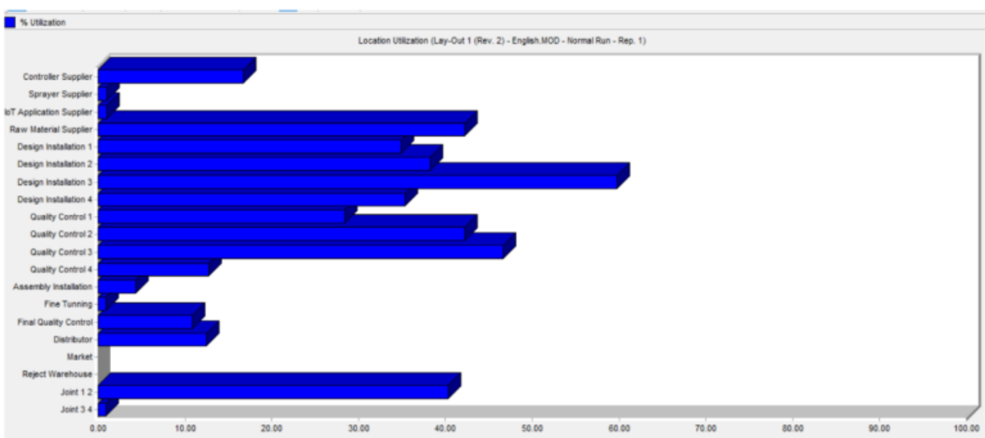


FIGURE 6. Location Utilization

CONCLUSION

This study concludes that social manufacturing is formed from stakeholders who have manufacturing resources to share, such as small, micro, and medium industries (SMEs), logistics service providers, and factory warehouse providers, forming a community called socialized manufacturing resources (SMR) and collaborate to produce a product. The implication of this research is forming an integrated production system based on the internet of things (IoT), which is different from the manual method so that all production processes can be monitored from anywhere and in real-time. Suggestions that can be given from the results of this study are that for further research, research can be carried out for social manufacturing in the same area and indifferent or far apart locations because this will affect production costs and product prices.

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