PROPOSAL PENELITIAN 2025

Rencana Pelaksanaan Penelitian: tahun 2025 s.d. tahun 2026

1. JUDUL PENELITIAN

Transformasi Digital pada Sistem Produksi melalui Social Manufacturing berbasis IoT dan AI untuk Meningkatkan Fleksibilitas Produksi

Bidang Fokus	Tema	Topik (jika ada)	Prioritas Riset
Produk rekayasa keteknikan	-	-	Digitalisasi

Rumpun Ilmu Level 1	Rumpun Ilmu Level 2	Rumpun Ilmu Level 3
ILMU TEKNIK	TEKNIK ELEKTRO DAN INFORMATIKA	Teknik Informatika

Skema Penelitian	Strata (Dasar/Terapan/ Pengembangan)	Nilai SBK	Target Akhir TKT	Lama Kegiatan
Penelitian Terapan - Luaran Prototipe	Riset Terapan	500.000.000	5	2 Tahun

2. IDENTITAS PENGUSUL

Nama, Peran	Jenis	Program Studi/Bagian	Bidang Tugas	ID Sinta
MARTI WIDYA SARI 0527037901 Ketua Pengusul Universitas PGRI Yogyakarta	Dosen	Informatika	Melakukan koordinasi dengan tim peneliti dan mitra; Membuat perencanaan dan konsep untuk pelaksanaan penelitian; Analisis kebutuhan sistem hardware dan software, serta integrasi sistem IoT dan AI; Melakukan pengujian sistem awal dan mengevaluasi hasil pengujian sistem; Menyusun luaran penelitian berupa draft kekayaan intelektual (paten sederhana) dan draft sertifikasi produk penelitian (sistem social manufacturing); Menyusun dokumen feasibility study	5974644
PRAHENUSA WAHYU CIPTADI 0527128402 Anggota Universitas PGRI Yogyakarta	Dosen	Informatika	Analisis sistem social manufacturing berbasis IoT dan AI; Merancang aplikasi sistem monitoring social manufacturing secara real-time; Pengujian aplikasi sistem monitoring; Evaluasi dan dokumentasi hasil pengujian aplikasi sistem monitoring; Menyusun luaran penelitian berupa	5992956

Nama, Peran	Jenis	Program Studi/Bagian	Bidang Tugas	ID Sinta
			kekayaan intelektual (hak cipta)	
ADI PRASETYO 0530128803 Anggota Universitas PGRI Yogyakarta	Dosen	Bisnis Digital	Analisis kebutuhan sistem hardware dan software (aplikasi), serta integrasi sistem IoT dan AI; Merancang aplikasi sistem monitoring social manufacturing berbasis IoT dan AI; Pengujian sistem yang sudah diintegrasikan (hardware dan software); Evaluasi dan dokumentasi hasil pengujian sistem; Menyusun luaran penelitian berupa kekayaan intelektual (hak cipta)	6776130
Anton Rahmat Widodo 6473020106730002 Anggota Bappeda Kabupaten Sleman	Umum	Riset dan pengembangan wilayah	Melakukan pendataan dan pemetaan UMKM di wilayah Sleman; Melakukan koordinasi dengan dinas perindustrian/dinas terkait sesuai tema penelitian; Menyiapkan materi sosialisasi dan FGD penelitian	-
ARYA NANDA EKA PUTRA 22111100013 Mahasiswa Universitas PGRI Yogyakarta	Mahasiswa	Informatika	Bertugas untuk menyiapkan FGD, pengujian sistem hardware dan software, serta membantu implementasi sistem	-
ERIKA AMALIA 22111100034 Mahasiswa Universitas PGRI Yogyakarta	Mahasiswa	Informatika	Melakukan pengujian sistem hardware dan software, membantu implementasi sistem, serta dokumentasi kegiatan penelitian	-
DWI ENDAH WAHYUNI 22111100036 Mahasiswa Universitas PGRI Yogyakarta	Mahasiswa	Informatika	Membantu implementasi sistem, dokumentasi kegiatan penelitian, survey dan observasi untuk penyusunan dokumen feasibility study	-

3. DOKUMEN PENDUKUNG

URL Artikel di jurnal sebagai penulis pertama (first author) atau penulis korespondensi (corresponding author) yang relevan dengan usulan penelitian
https://sciendo.com/article/10.2478/mspe-2022-0029

4. MITRA KERJASAMA PENELITIAN (Jika Ada)

Pelaksanaan penelitian dapat melibatkan mitra kerjasama yaitu mitra kerjasama dalam melaksanakan penelitian, mitra sebagai calon pengguna hasil penelitian, atau mitra investor

Mitra	Nama Mitra	Dana
Badan Perencanaan dan Pembangunan Daerah Kabupaten Sleman	Ir. Dwi Anta Sudibya, M.T.	Tahun 1 Rp10.000.000,00 Tahun 2 Rp. 10.000.000,00

5. LUARAN DAN TARGET CAPAIAN

Luaran Wajib

Tahun Luaran	Kategori Luaran	Jenis Luaran	Status target capaian	Keterangan
1	Purwarupa/Prototipe	Purwarupa/Prototipe	Ada / Tersedia	Prototype sistem social manufacturing
1	Kekayaan Intelektual (KI)	Paten Sederhana	Terdaftar	Prototype sistem social manufacturing yang didaftarkan Paten Sederhana
2	Purwarupa/Prototipe	Purwarupa/Prototipe	Ada / Tersedia	Sertifikasi prototipe
2	Dokumen Feasibility Study	Dokumen Feasibility Study	Diterima (Granted)	Dokumen Feasibility Study berdasar kebutuhan pasar

6. ANGGARAN

Rencana Anggaran Biaya penelitian mengacu pada PMK dan buku Panduan Penelitian dan Pengabdian kepada Masyarakat yang berlaku.

Total RAB 2 Tahun Rp838.797.000,00

Tahun 1 Total Rp425.373.000,00

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Bahan	ATK	Harddisk eksternal Seagate One Touch 5 TB	Paket	3	2.325.000	6.975.000
Bahan	ATK	Label dan barcode stiker untuk inventarisasi	Paket	1	250.000	250.000
Bahan	Bahan Penelitian (Habis Pakai)	Board expansion	Unit	14	225.000	3.150.000
Bahan	Bahan Penelitian (Habis Pakai)	Adaptor 5V2A	Unit	7	425.000	2.975.000
Bahan	Bahan Penelitian (Habis Pakai)	Node MCU esp8266	Unit	14	250.000	3.500.000
Bahan	Bahan Penelitian (Habis Pakai)	Baterai dan adaptor daya USB-C 65W	Unit	5	650.000	3.250.000
Bahan	Bahan Penelitian (Habis Pakai)	Kabel dan konektor (jumper, konektor USB, terminal blok)	Unit	2	1.500.000	3.000.000
Bahan	Bahan Penelitian (Habis Pakai)	Kabel Gland	Unit	2	350.000	700.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan pembuatan aplikasi android (software android studio, eclipse, MIT App)	Unit	4	7.500.000	30.000.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan produk industri untuk uji coba implementasi sistem	Unit	10	350.000	3.500.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan pembuatan aplikasi web	Unit	2	15.000.000	30.000.000
Bahan	Bahan Penelitian (Habis Pakai)	RFID Card 13.56 MHz	Unit	64	15.000	960.000
Bahan	Bahan Penelitian	LCD 16x2	Unit	7	350.000	2.450.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
	(Habis Pakai)					
Bahan	Bahan Penelitian (Habis Pakai)	Casing komponen elektronik	Unit	7	300.000	2.100.000
Bahan	Bahan Penelitian (Habis Pakai)	Cloud storage-NAS Private Cloud Storage Home NAS	Unit	2	4.480.000	8.960.000
Bahan	Bahan Penelitian (Habis Pakai)	PN532 NFC	Unit	20	260.000	5.200.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan prototype produk dari industri	Unit	10	225.000	2.250.000
Bahan	Barang Persediaan	Single-board Raspberry	Unit	10	2.314.000	23.140.000
Bahan	Barang Persediaan	Microcontroller arduino uno	Unit	10	550.000	5.500.000
Bahan	Barang Persediaan	Modul komunikasi IoT (Zigbee)	Unit	10	1.245.000	12.450.000
Bahan	Barang Persediaan	Memory Sony 64GB SF-M Tough Series UHS-II SDXC Memory Card	Unit	8	699.000	5.592.000
Bahan	Barang Persediaan	Peralatan image processing EYD PC01 Webcam	Unit	4	1.299.000	5.196.000
Bahan	Barang Persediaan	Pembuatan konveyor untuk pengujian produk industri	Unit	5	225.000	1.125.000
Bahan	Barang Persediaan	Modul AI (untuk image processing)	Unit	2	16.000.000	32.000.000
Bahan	Barang Persediaan	Sensor IoT	Unit	20	175.000	3.500.000
Pengumpulan Data	HR Pembantu Peneliti	Asisten peneliti	OJ	20	300.000	6.000.000
Pengumpulan Data	HR Pembantu Peneliti	Database management	OJ	10	150.000	1.500.000
Pengumpulan Data	HR Petugas Survei	Survey awal penelitian	OH/OR	20	400.000	8.000.000
Pengumpulan Data	Transport	Transport untuk survey pembuatan draft feasibility study	OK (kali)	12	300.000	3.600.000
Pengumpulan Data	Transport	Penyusunan draft sertifikasi prototype sistem	OK (kali)	7	300.000	2.100.000
Pengumpulan Data	Transport	FGD persiapan penelitian	OK (kali)	14	200.000	2.800.000
Pengumpulan Data	Transport	Transport tim peneliti ke lokasi penelitian	OK (kali)	18	300.000	5.400.000
Pengumpulan Data	Transport	Transport pengujian sistem di skala terbatas	OK (kali)	10	300.000	3.000.000
Pengumpulan Data	Transport	Transport pemetaan lokasi industri	OK (kali)	7	200.000	1.400.000
Pengumpulan Data	Transport	Transport pengumpulan data tim peneliti	OK (kali)	8	300.000	2.400.000
Pengumpulan Data	Uang Harian	Penyusunan poster hasil penelitian	OH	4	400.000	1.600.000
Pengumpulan Data	Uang Harian	Pembuatan video dokumentasi pengujian	OH	10	400.000	4.000.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
		sistem di 5 titik				
Pengumpulan Data	Uang Harian	Pemasangan dan pemeliharaan sensor IoT	OH	8	300.000	2.400.000
Pengumpulan Data	Uang Harian	Uang harian rapat di kantor	OH	15	250.000	3.750.000
Pengumpulan Data	Uang Harian	Uang harian rapat luar kantor	OH	15	300.000	4.500.000
Pengumpulan Data	Uang Harian	Pengujian sistem di skala terbatas	OH	7	400.000	2.800.000
Pengumpulan Data	Uang Harian	Pembuatan video dokumentasi implementasi sistem	OH	8	400.000	3.200.000
Pengumpulan Data	Uang Harian	Survey penentuan industri manufaktur	OH	7	300.000	2.100.000
Pengumpulan Data	Biaya konsumsi	Konsumsi FGD penelitian	OH	20	125.000	2.500.000
Pengumpulan Data	Biaya konsumsi	Survey penentuan industri manufaktur	OH	7	150.000	1.050.000
Pengumpulan Data	Biaya konsumsi	Konsumsi survey dan observasi	OH	10	200.000	2.000.000
Pengumpulan Data	Biaya konsumsi	Konsumsi rapat progress penelitian di dalam kantor	OH	15	100.000	1.500.000
Pengumpulan Data	Biaya konsumsi	Konsumsi rapat di luar kantor	OH	15	150.000	2.250.000
Pengumpulan Data	HR Pembantu Lapangan	HR pembantu pengujian sistem	OH	6	400.000	2.400.000
Pengumpulan Data	HR Pembantu Lapangan	HR pembantu survey dan observasi	OH	6	300.000	1.800.000
Pengumpulan Data	Honorarium narasumber	Narasumber pelatihan dan pendampingan mitra	OJ	6	1.500.000	9.000.000
Pengumpulan Data	Honorarium narasumber	Narasumber FGD	OJ	3	900.000	2.700.000
Sewa Peralatan	Peralatan penelitian	Sewa hosting web sistem monitoring untuk 1 tahun	Unit	1	3.000.000	3.000.000
Sewa Peralatan	Peralatan penelitian	Sewa cloud storage untuk 8 bulan	Unit	8	250.000	2.000.000
Sewa Peralatan	Peralatan penelitian	Sewa perangkat IoT (Insutrial grade)	Unit	4	500.000	2.000.000
Sewa Peralatan	Peralatan penelitian	Sewa perangkat manufaktur digiral	Unit	4	400.000	1.600.000
Sewa Peralatan	Obyek penelitian	Produk industri/UMKM untuk uji coba	Unit	10	300.000	3.000.000
Sewa Peralatan	Obyek penelitian	Sewa tempat untuk uji coba sistem di industri manufaktur skala kecil/ menegah	Unit	5	500.000	2.500.000
Sewa Peralatan	Ruang penunjang penelitian	Sewa ruang laboratorium untuk perancangan dan pengujian sistem	Unit	8	1.500.000	12.000.000
Sewa Peralatan	Ruang penunjang penelitian	Ruang untuk FGD persiapan penelitian	Unit	1	1.500.000	1.500.000
Sewa Peralatan	Ruang penunjang penelitian	Ruang penunjang untuk expo penelitian	Unit	2	1.000.000	2.000.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Sewa Peralatan	Kendaraan	Untuk transportasi selama pengujian sistem	OK (kali)	8	1.025.000	8.200.000
Analisis Data	HR Pengolah Data	HR pengolahan dataset penelitian	P (penelitian)	2	750.000	1.500.000
Analisis Data	HR Pengolah Data	HR pengolah data dan analisis hasil penelitian	P (penelitian)	10	500.000	5.000.000
Analisis Data	HR Pengolah Data	HR pengolah data untuk luaran draft paten sederhana	P (penelitian)	2	750.000	1.500.000
Analisis Data	HR Pengolah Data	HR Pengolah data hasil penelitian	P (penelitian)	4	400.000	1.600.000
Analisis Data	Honorarium narasumber	Konsultan sistem berbasis IoT dan AI	OJ	4	2.000.000	8.000.000
Analisis Data	Honorarium narasumber	Narasumber proses analisis data AI	OJ	4	1.000.000	4.000.000
Analisis Data	Biaya analisis sampel	Analisis sampel data awal penelitian	Unit	3	400.000	1.200.000
Analisis Data	Biaya analisis sampel	Biaya analisis sampel untuk draft dokumen feasibility study	Unit	2	4.500.000	9.000.000
Analisis Data	Biaya analisis sampel	Analisis data revisi sistem	Unit	2	500.000	1.000.000
Analisis Data	Uang Harian	Rapat luar kantor untuk konsultasi dengan ahli pengolahan AI	OH	5	300.000	1.500.000
Analisis Data	Uang Harian	Revisi model sistem	OH	6	500.000	3.000.000
Analisis Data	Uang Harian	Uang harian tenaga ahli pengolahan data dan AI	OH	10	300.000	3.000.000
Analisis Data	Uang Harian	Pembuatan model sistem	OH	6	500.000	3.000.000
Analisis Data	Uang Harian	Analisis dan evaluasi hasil pengujian sistem	OH	6	500.000	3.000.000
Analisis Data	Uang Harian	Rapat di dalam kantor untuk analisis data dan AI	OH	12	200.000	2.400.000
Analisis Data	Transport Lokal	Transport pengujian dan analisis model sistem	OK (kali)	14	200.000	2.800.000
Analisis Data	Transport Lokal	Transport perancangan model sistem	OK (kali)	7	200.000	1.400.000
Analisis Data	Transport Lokal	Transport proses pengolahan data dan AI	OK (kali)	5	200.000	1.000.000
Analisis Data	Transport Lokal	Transport implementasi sistem	OK (kali)	14	200.000	2.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Rapat pembuatan dokumen uji produk	OH	14	300.000	4.200.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Uang harian tim peneliti rapat luar kantor	OH	14	200.000	2.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Rapat studi literatur dan analisis kebutuhan sistem	OH	9	200.000	1.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Uang harian penyusunan draft paten sederhana	OH	5	300.000	1.500.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Finalisasi dokumen feasibility study	OH	6	300.000	1.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Konsumsi rapat dengan mitra (Bappeda)	OH	10	200.000	2.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat pembuatan video dokumentasi penelitian	OH	7	150.000	1.050.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat penyusunan poster penelitian	OH	7	150.000	1.050.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat koordinasi penyusunan laporan akhir penelitian	OH	12	150.000	1.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Konsumsi rapat luar kantor	OH	14	150.000	2.100.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat penyusunan luaran penelitian berupa produk sistem monitoring	OH	14	200.000	2.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat koordinasi penyusunan luaran prototype sistem	OH	12	150.000	1.800.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Konsumsi rapat penyusunan draft feasibility study	OH	5	200.000	1.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Konsumsi rapat penyusunan luaran penelitian berupa hak cipta	OH	7	200.000	1.400.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat koordinasi penyusunan laporan kemajuan penelitian	OH	10	150.000	1.500.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya Pendaftaran KI	Konsultasi draft paten sederhana	Paket	7	200.000	1.400.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya Pendaftaran KI	Pendaftaran paten sederhana	Paket	1	1.300.000	1.300.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya Pendaftaran KI	Biaya pendaftaran KI Hak CIpta sebagai luaran tambahan (2 produk)	Paket	2	300.000	600.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya pembuatan dokumen uji produk	Pembuatan dokumen uji produk	Paket	1	4.500.000	4.500.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya pembuatan dokumen uji produk	Pembuatan dokumen feasibility study	Paket	1	5.000.000	5.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya pembuatan dokumen uji produk	Pengujian sistem di lokasi industri manufaktur/umkm	Paket	2	3.000.000	6.000.000

Tahun 2 Total Rp413.424.000,00

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Bahan	ATK	Map, binder, dan folder dokumen	Paket	2	250.000	500.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Bahan	ATK	Harddisk eksternal Seagate One Touch 5 TB	Paket	2	2.325.000	4.650.000
Bahan	Bahan Penelitian (Habis Pakai)	Adaptor 5V2A	Unit	7	425.000	2.975.000
Bahan	Bahan Penelitian (Habis Pakai)	Casing komponen elektronik	Unit	7	300.000	2.100.000
Bahan	Bahan Penelitian (Habis Pakai)	RFID Card 13.56 MHz	Unit	64	15.000	960.000
Bahan	Bahan Penelitian (Habis Pakai)	Kabel Gland	Unit	2	350.000	700.000
Bahan	Bahan Penelitian (Habis Pakai)	Node MCU esp8266	Unit	14	250.000	3.500.000
Bahan	Bahan Penelitian (Habis Pakai)	Baterai dan adaptor daya USB-C 65W	Unit	5	650.000	3.250.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan produk industri untuk uji coba implementasi sistem	Unit	10	350.000	3.500.000
Bahan	Bahan Penelitian (Habis Pakai)	Kabel dan konektor (jumper, konektor USB, terminal blok)	Unit	2	1.500.000	3.000.000
Bahan	Bahan Penelitian (Habis Pakai)	LCD 16x2	Unit	7	350.000	2.450.000
Bahan	Bahan Penelitian (Habis Pakai)	Board expansion	Unit	14	225.000	3.150.000
Bahan	Bahan Penelitian (Habis Pakai)	Microcontroller arduino uno	Unit	10	550.000	5.500.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan prototype produk dari industri	Unit	10	225.000	2.250.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan pembuatan aplikasi web	Unit	2	15.000.000	30.000.000
Bahan	Bahan Penelitian (Habis Pakai)	PN532 NFC	Unit	20	260.000	5.200.000
Bahan	Bahan Penelitian (Habis Pakai)	Bahan pembuatan aplikasi android (software android studio, eclipse, MIT App)	Unit	4	7.500.000	30.000.000
Bahan	Bahan Penelitian (Habis Pakai)	Cloud storage-NAS Private Cloud Storage Home NAS	Unit	2	4.480.000	8.960.000
Bahan	Barang Persediaan	Peralatan image processing EYD PC01 Webcam	Unit	4	1.299.000	5.196.000
Bahan	Barang Persediaan	Modul AI (untuk image processing)	Unit	2	16.000.000	32.000.000
Bahan	Barang Persediaan	Memory Sony 64GB SFM Tough Series UHS-II SDXC Memory Card	Unit	7	699.000	4.893.000
Bahan	Barang	Modul komunikasi IoT	Unit	10	1.245.000	12.450.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
	Persediaan	(Zigbee)				
Bahan	Barang Persediaan	Single-board Raspberry	Unit	10	2.314.000	23.140.000
Bahan	Barang Persediaan	Sensor IoT	Unit	20	175.000	3.500.000
Pengumpulan Data	HR Pembantu Peneliti	Pengelolaan database	OJ	14	150.000	2.100.000
Pengumpulan Data	HR Petugas Survei	Survei kebutuhan pasar untuk feasibility study	OH/OR	14	200.000	2.800.000
Pengumpulan Data	HR Petugas Survei	Survei industri manufaktur untuk implementasi sistem	OH/OR	6	200.000	1.200.000
Pengumpulan Data	Transport	Transport pengujian sistem pada lingkungan sebenarnya	OK (kali)	14	200.000	2.800.000
Pengumpulan Data	Transport	Pemasangan dan pemeliharaan sensor IoT	OK (kali)	9	300.000	2.700.000
Pengumpulan Data	Transport	Penyusunan poster hasil penelitian	OK (kali)	5	300.000	1.500.000
Pengumpulan Data	Transport	Transport untuk survei pembuatan draft feasibility study	OK (kali)	14	300.000	4.200.000
Pengumpulan Data	Transport	Penyusunan draft sertifikasi prototype sistem	OK (kali)	10	300.000	3.000.000
Pengumpulan Data	Transport	Transport tim peneliti ke lokasi penelitian	OK (kali)	14	300.000	4.200.000
Pengumpulan Data	Transport	Rapat di luar kantor	OK (kali)	14	200.000	2.800.000
Pengumpulan Data	Transport	Transport pemetaan lokasi industri manufaktur	OK (kali)	7	200.000	1.400.000
Pengumpulan Data	Transport	Pembuatan video dokumentasi implementasi sistem	OK (kali)	8	400.000	3.200.000
Pengumpulan Data	Transport	FGD persiapan penelitian lanjutan	OK (kali)	15	200.000	3.000.000
Pengumpulan Data	Transport	Pembuatan video dokumentasi pengujian sistem di 5 titik	OK (kali)	10	400.000	4.000.000
Pengumpulan Data	Uang Harian	Uang harian pemetaan lokasi industri manufaktur	OH	7	300.000	2.100.000
Pengumpulan Data	Uang Harian	Pengujian sistem pada lingkungan sebenarnya	OH	14	300.000	4.200.000
Pengumpulan Data	Uang Harian	Pembuatan video dokumentasi implementasi sistem	OH	8	200.000	1.600.000
Pengumpulan Data	Uang Harian	Pembuatan video dokumentasi pengujian sistem di 5 titik	OH	10	200.000	2.000.000
Pengumpulan Data	Uang Harian	Pemasangan dan pemeliharaan sensor IoT	OH	9	300.000	2.700.000
Pengumpulan Data	Uang Harian	Uang harian rapat luar kantor	OH	14	300.000	4.200.000
Pengumpulan Data	Uang Harian	Penyusunan poster hasil penelitian	OH	5	300.000	1.500.000
Pengumpulan Data	Uang Harian	Uang harian rapat di kantor	OH	21	200.000	4.200.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Pengumpulan Data	Biaya konsumsi	Konsumsi survei dan observasi	OH	10	200.000	2.000.000
Pengumpulan Data	Biaya konsumsi	Konsumsi survei dan observasi	OH	10	200.000	2.000.000
Pengumpulan Data	Biaya konsumsi	Konsumsi FGD penelitian	OH	20	150.000	3.000.000
Pengumpulan Data	Biaya konsumsi	Konsumsi rapat progress penelitian di dalam kantor	OH	15	150.000	2.250.000
Pengumpulan Data	Biaya konsumsi	Konsumsi rapat di luar kantor	OH	15	200.000	3.000.000
Pengumpulan Data	HR Pembantu Lapangan	HR pembantu pengujian sistem	OH	8	400.000	3.200.000
Pengumpulan Data	HR Pembantu Lapangan	HR pembantu survei dan observasi	OH	8	300.000	2.400.000
Pengumpulan Data	HR Pembantu Lapangan	HR pembantu implementasi sistem	OH	14	300.000	4.200.000
Pengumpulan Data	Honorarium narasumber	Narasumber pelatihan dan pendampingan mitra	OJ	6	1.500.000	9.000.000
Pengumpulan Data	Honorarium narasumber	Narasumber FGD	OJ	2	2.700.000	5.400.000
Sewa Peralatan	Peralatan penelitian	Sewa perangkat manufaktur digiral	Unit	6	400.000	2.400.000
Sewa Peralatan	Peralatan penelitian	Sewa hosting web sistem monitoring untuk 2 tahun	Unit	2	3.000.000	6.000.000
Sewa Peralatan	Peralatan penelitian	Sewa perangkat IoT (Industrial grade)	Unit	6	500.000	3.000.000
Sewa Peralatan	Peralatan penelitian	Sewa cloud storage untuk 1 tahun	Unit	12	250.000	3.000.000
Sewa Peralatan	Obyek penelitian	Sewa tempat untuk uji coba sistem di industri manufaktur skala kecil/ menegah	Unit	5	500.000	2.500.000
Sewa Peralatan	Obyek penelitian	Produk industri/UMKM untuk uji coba	Unit	15	300.000	4.500.000
Sewa Peralatan	Ruang penunjang penelitian	Ruang penunjang untuk expo penelitian	Unit	2	1.000.000	2.000.000
Sewa Peralatan	Ruang penunjang penelitian	Ruang untuk FGD persiapan penelitian	Unit	1	1.500.000	1.500.000
Sewa Peralatan	Ruang penunjang penelitian	Sewa ruang boratorium untuk erancangan dan pengujian sistem	Unit	8	1.500.000	12.000.000
Sewa Peralatan	Kendaraan	Transportasi selama pengujian sistem	OK (kali)	8	1.025.000	8.200.000
Analisis Data	HR Pengolah Data	HR pengolah data dan analisis hasil penelitian	P (penelitia n)	4	750.000	3.000.000
Analisis Data	HR Pengolah Data	HR pengolah data untuk luaran draft paten sederhana	P (penelitia n)	2	750.000	1.500.000
Analisis Data	HR Pengolah Data	HR pengolahan dataset penelitian	P (penelitia n)	3	750.000	2.250.000
Analisis Data	HR Pengolah Data	HR Pengolah data hasil penelitian	P (penelitia n)	4	500.000	2.000.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Analisis Data	Honorarium narasumber	Narasumber analisis data untuk luaran peneltiian prototype bersertifikat	OJ	6	400.000	2.400.000
Analisis Data	Honorarium narasumber	Konsultan sistem berbasis IoT dan AI	OJ	3	2.000.000	6.000.000
Analisis Data	Biaya analisis sampel	Uang harian pengolahan data dan AI	Unit	8	300.000	2.400.000
Analisis Data	Biaya analisis sampel	Analisis sampel data awal penelitian	Unit	3	400.000	1.200.000
Analisis Data	Biaya analisis sampel	Biaya analisis sampel untuk draft dokumen feasibility study	Unit	2	4.500.000	9.000.000
Analisis Data	Biaya analisis sampel	Analisis data revisi sistem	Unit	2	500.000	1.000.000
Analisis Data	Uang Harian	Revisi model sistem yang akan diimplementasikan	OH	7	500.000	3.500.000
Analisis Data	Uang Harian	Rapat luar kantor untuk konsultasi dengan ahli pengolahan AI	OH	5	300.000	1.500.000
Analisis Data	Uang Harian	Rapat di dalam kantor untuk analisis data dan AI	OH	10	200.000	2.000.000
Analisis Data	Uang Harian	Rapat di luar kantor pembahasan feasibility study	OH	8	300.000	2.400.000
Analisis Data	Transport Lokal	Rapat luar kantor untuk konsultasi dengan ahli pengolahan AI	OK (kali)	5	200.000	1.000.000
Analisis Data	Transport Lokal	Transport proses analisis data dan AI	OK (kali)	5	200.000	1.000.000
Analisis Data	Transport Lokal	Transport implementasi sistem	OK (kali)	10	300.000	3.000.000
Analisis Data	Transport Lokal	Transport pengujian dan analisis model sistem	OK (kali)	14	200.000	2.800.000
Analisis Data	Transport Lokal	Uji coba implementasi sistem di lokasi industri manufaktur	OK (kali)	5	300.000	1.500.000
Analisis Data	Transport Lokal	Transport perancangan model sistem	OK (kali)	10	200.000	2.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Uang harian rapat di luar kantor pembahasan draft paten sederhana	OH	10	300.000	3.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Uang harian rapat di luar kantor penyiapan sertifikasi prototype	OH	8	300.000	2.400.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Rapat pembahasan sertifikasi produk prototype	OH	7	150.000	1.050.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Uang harian rapat di luar kantor	Uang harian rapat di luar kantor penyusunan dokumen feasibiltiy study	OH	10	300.000	3.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat penyusunan poster penelitian	OH	8	150.000	1.200.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat di luar kantor pembahasan draft paten sederhana	OH	10	150.000	1.500.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat penyusunan video dokumentasi penelitian	OH	8	150.000	1.200.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat bersama mitra untuk pembahasan progres penelitian	OH	15	150.000	2.250.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat penyusunan KI Hak Cipta sebagai luaran tambahan (2 produk)	OH	7	150.000	1.050.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	rapat di luar kantor penyusunan dokumen feasibiltiy study	OH	10	150.000	1.500.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat penyusunan laporan akhir penelitian	OH	10	150.000	1.500.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat di luar kantor penyiapan sertifikasi prototype	OH	8	150.000	1.200.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya konsumsi rapat	Rapat di dalam kantor untuk pengujian model sistem	OH	10	125.000	1.250.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya Pendaftaran KI	Biaya pendaftaran KI Hak Cipta sebagai luaran tambahan	Paket	2	300.000	600.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya pembuatan dokumen uji produk	Biaya pembuatan dokumen uji produk prototype tersertifikasi	Paket	1	2.500.000	2.500.000

A. JUDUL *Tuliskan judul usulan penelitian maksimal 20 kata*
Transformasi Digital pada Sistem Produksi melalui *Social Manufacturing* berbasis IoT dan AI untuk Meningkatkan Fleksibilitas Produksi
B. RINGKASAN *Isian ringkasan penelitian tidak lebih dari 300 kata yang berisi urgensi, tujuan, metode, dan luaran yang ditargetkan*
Transformasi digital dalam sistem produksi menjadi kebutuhan mendesak di era Industri 4.0 untuk meningkatkan fleksibilitas dan daya saing industri manufaktur. *Social manufacturing* merupakan salah satu konsep yang mendukung peningkatan fleksibilitas pada sistem produksi, yang berbasis kolaborasi dan konektivitas, di mana para pelaku usaha, yang terdiri dari produsen, pemasok, bahkan individu, dapat berpartisipasi secara aktif dalam proses produksi melalui platform digital. *Social manufacturing* berbasis *Internet of Things* (IoT) dan kecerdasan buatan (AI) memungkinkan kolaborasi yang lebih dinamis dalam proses produksi, meningkatkan efisiensi, serta mengurangi waktu dan biaya operasional. Implementasi teknologi Industri 4.0 pada sistem produksi dapat meningkatkan fleksibilitas produksi dalam pembuatan produk sesuai kebutuhan pelanggan melalui sistem *social manufacturing*. Pesatnya perubahan kebutuhan konsumen dan kompleksitas produksi membuat industri manufaktur dituntut untuk mengadopsi solusi berbasis teknologi guna mengoptimalkan proses produksi secara *real-time*. **Urgensi** penelitian ini adalah untuk melakukan proses transformasi digital yang dapat meningkatkan fleksibilitas produksi melalui penerapan konsep *social manufacturing* berbasis IoT dan AI untuk meningkatkan daya saing produk industri manufaktur. **Tujuan** penelitian ini adalah untuk mengeksplorasi penerapan teknologi IoT dan AI dalam *social manufacturing* yang dapat meningkatkan fleksibilitas produksi, serta mengembangkan model penerapan bagi industri manufaktur. **Kebaruan dan kontribusi** terhadap ilmu pengetahuan dalam penelitian ini adalah pengembangan model *social manufacturing* berbasis IoT dan AI untuk meningkatkan fleksibilitas produksi, akan mendukung transformasi digital pada industri manufaktur agar dapat bersaing di era Industri 4.0. **Metode** penelitian dilakukan dalam beberapa tahapan, antara lain: 1) analisis kebutuhan sistem; 2) perancangan model sistem berbasis IoT dan AI; 3) pengembangan dan penerapan sistem; 4) pengujian sistem, serta 5) evaluasi dan analisis hasil pengujian sistem. Penelitian ini akan dilaksanakan selama dua tahun dengan target **luaran** pada **tahun ke-1** berupa *prototype* sistem *social manufacturing* berbasis IoT dan AI, dan Paten Sederhana, kemudian untuk **tahun ke-2** berupa *prototype social manufacturing* yang sudah tersertifikasi serta sebuah dokumen *Feasibility Study*.
C. KATA KUNCI *Isian 5 kata kunci yang dipisahkan dengan tanda titik koma (;)*
social manufacturing; internet of things; sistem produksi; artificial intelligence; transformasi digital

D. PENDAHULUAN

Pendahuluan penelitian tidak lebih dari 1500 kata yang memuat, latar belakang, rumusan permasalahan yang akan diteliti, pendekatan pemecahan masalah, state-of-the-art dan kebaruan, peta jalan (road map) penelitian setidaknya 5 tahun. Sitasi disusun dan ditulis berdasarkan sistem nomor sesuai dengan urutan pengutipan.

1. Latar Belakang

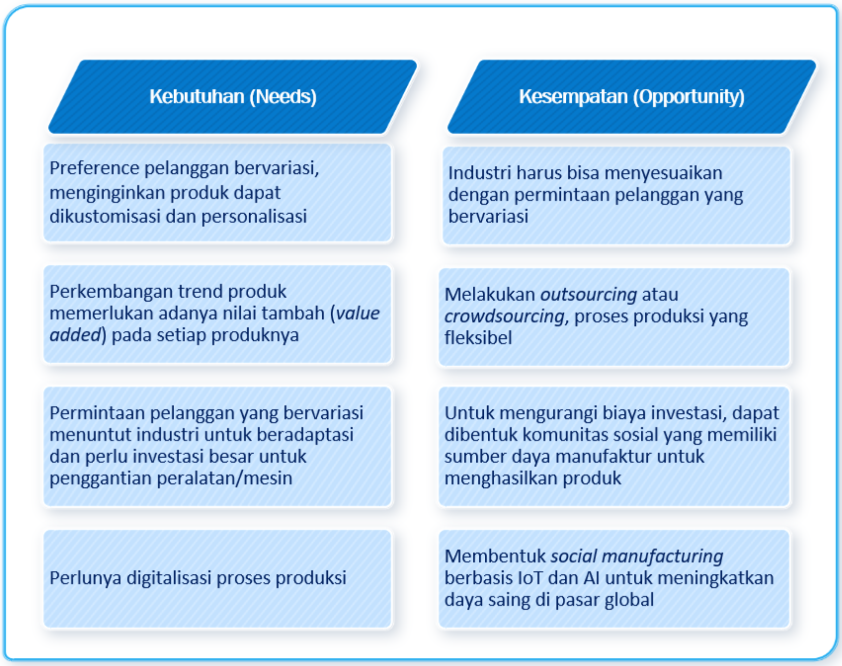
Making Indonesia 4.0 adalah inisiatif pemerintah Indonesia untuk mempersiapkan dan mempercepat transformasi industri manufaktur menuju era Industri 4.0. Tujuan dari *roadmap* tersebut adalah untuk meningkatkan daya saing industri nasional di era digital, meningkatkan efisiensi dan kualitas produk melalui integrasi teknologi, informasi dan komunikasi, serta mendorong ekonomi berkelanjutan. Industri 4.0 menggabungkan semua teknologi terbaru seperti jaringan sensor, IoT, AI, sistem kontrol, robotik, untuk membentuk sebuah *Cyber-Physical System* (CPS) dan pabrik pintar **[1]**. Transformasi digital dalam industri manufaktur telah menjadi pendorong utama dalam peningkatan efisiensi dan fleksibilitas produksi. Integrasi teknologi seperti IoT dan AI memungkinkan sistem produksi lebih fleksibel dan adaptif terhadap perubahan permintaan pasar [2]. Penerapan IoT dalam industri manufaktur memungkinkan pengumpulan data real-time dari mesin maupun peralatan produksi, yang kemudian dapat dipantau melalui sebuah sistem monitoring secara online **[3]**.

Social manufacturing adalah konsep manufaktur yang berbasis kolaborasi dan konektivitas, di mana para pelaku usaha, yang terdiri dari produsen, pemasok, pelanggan bahkan individu, dapat berpartisipasi secara aktif dalam proses produksi melalui platform digital [3]. Pelaku usaha yang terlibat dalam sistem *social manufacturing* disebut dengan *socialized manufacturing resources* (SMR), yang dapat berbentuk pabrik, industri kecil/menengah, usaha mikro kecil menengah (UMKM), bahkan usaha individu. Konsep *social manufacturing*, yang memanfaatkan platform digital untuk kolaborasi antar pelaku industri, semakin memperkuat kemampuan adaptasi ini [4]. Sebuah studi oleh Sari et al., tentang pengembangan model sistem produksi terintegrasi berbasis *social manufacturing*, yang melibatkan SMR dan CPS telah dilakukan untuk memproduksi sebuah produk alat kesehatan berupa bilik sanitasi berbasis IoT, yang melibatkan 4 (empat) industri manufaktur skala kecil/menengah **[5]**. Studi literatur terkait perbandingan pengembangan model *social manufacturing* yang menggunakan berbagai teknologi informasi dan komunikasi seperti IoT, AI, CPS dan 3D Printing yang telah berhasil diterapkan pada sistem *social manufacturing* di beberapa negara dapat menjadi acuan pengembangan model selanjutnya **[6]**.

Sari et al. telah memetakan berbagai mode manufaktur canggih telah diusulkan dalam beberapa tahun terakhir, dan sebagian besar menekankan kolaborasi dan interkoneksi, seperti CPS, *crowdsourcing*, manufaktur berbasis *cloud*, dan manufaktur terdistribusi **[7]**. Implementasi teknologi digital dalam sistem produksi berbasis *social manufacturing* juga berdampak signifikan pada efisiensi operasional [8]. Integrasi AI dalam sistem produksi memungkinkan analisis data yang lebih mendalam dan pengambilan keputusan yang lebih tepat waktu [9]. AI dapat memprediksi trend permintaan, mengoptimalkan jadwal produksi, serta mendeteksi potensi masalah sebelum terjadi, sehingga meningkatkan efisiensi operasional [10]. Implementasi transformasi digital melalui *social manufacturing* berbasis IoT dan AI tidak lepas dari tantangan, seperti integrasi teknologi baru ke dalam sistem produksi yang sudah ada. Industri manufaktur perlu memastikan bahwa infrastruktur teknologi tersebut mampu mendukung implementasi IoT dan

AI tanpa mengganggu operasi yang sedang berjalan [11]. Meskipun demikian, potensi keuntungan yang ditawarkan oleh transformasi digital dalam sistem produksi melalui *social manufacturing* berbasis IoT dan AI sangat signifikan, seperti disajikan dalam analisis SWOT pada Gambar 1.

Gambar 1. Analisis SWOT



Gambar 2. Kebutuhan dan kesempatan pengembangan sistem produksi melalui *social manufacturing*

Peningkatan fleksibilitas produksi memungkinkan industri manufaktur untuk merespons perubahan pasar dengan lebih cepat, serta efisiensi operasional yang lebih tinggi dapat mengurangi biaya produksi dan meningkatkan daya saing. Berdasar hal tersebut, penelitian tentang transformasi digital pada sistem produksi melalui *social manufacturing* menjadi sangat relevan. Sari et al. telah merangkum kebutuhan dan kesempatan untuk pengembangan model sistem produksi melalui *social manufacturing* [5] yang disajikan pada Gambar 2.

Berdasar penelitian-penelitian tersebut, serta melihat kebutuhan dan kesempatan untuk pengembangan sistem produksi melalui *social manufacturing*, maka pada penelitian ini akan dilakukan pengembangan model sistem produksi melalui *social manufacturing* berbasis IoT dan AI untuk meningkatkan fleksibilitas produksi, guna mendukung transformasi digital pada industri manufaktur.

2. Rumusan Permasalahan

Seiring perkembangan teknologi informasi dan komunikasi, industri manufaktur dituntut untuk lebih fleksibel karena permintaan dari pelanggan berubah-ubah, dan adaptif dalam proses produksinya untuk menghadapi era Industri 4.0 dan meningkatkan daya saing produk. Namun masih terdapat beberapa permasalahan utama yang perlu diatasi dalam penerapan transformasi digital melalui *social manufacturing* berbasis IoT dan AI, yaitu:

a) Bagaimana model implementasi yang optimal untuk meningkatkan efisiensi dan fleksibilitas dalam proses produksi melalui *social manufacturing*
b) Bagaimana peran IoT dan AI dalam *social manufacturing* untuk meningkatkan fleksibilitas produksi
c) Bagaimana dampak transformasi digital terhadap kinerja operasional dan daya saing industri manufaktur

3. Pendekatan Pemecahan Masalah

Pendekatan pemecahan masalah pada penelitian ini dilakukan melalui beberapa tahapan sebagai berikut.

a) Bagaimana model implementasi yang optimal untuk meningkatkan efisiensi dan fleksibilitas dalam proses produksi melalui *social manufacturing:*
   Melalui identifikasi kebutuhan industri, perancangan dan pengembangan model *social manufacturing*, menentukan struktur kolaborasi antara produsen, pemasok, pelanggan dan *stakeholder* yang lain, simulasi dan validasi model sistem, pembuatan prototype dan implementasi sistem, evaluasi dan penyempurnaan berdasar *feedback* dari industri
b) Bagaimana peran IoT dan AI dalam *social manufacturing* untuk meningkatkan fleksibilitas produksi:
   Melalui analisis peran IoT dan AI dalam *social manufacturing*, identifikasi elemen *social manufacturing* yang dapat dioptimalkan dengan teknologi ini, pengujian konektivitas IoT dan AI dalam sistem produksi berbasis *social manufacturing*
c) Bagaimana dampak transformasi digital terhadap kinerja operasional dan daya saing industri manufaktur:
   Melalui analisis dampak transformasi digital dalam industri manufaktur, serta pengukuran kinerja operasional dengan membandingkan data sebelum dan sesudah implementasi digitalisasi

Pendekatan pemecahan masalah ini diharapkan dapat memberikan solusi yang dapat diterapkan oleh industri manufaktur dalam proses produksi melalui *social manufacturing* berbasis IoT dan AI.

4. *State of the Art* dan Kebaruan

Transformasi digital dalam sistem produksi telah menjadi perhatian utama dalam industri untuk meningkatkan efisiensi, fleksibilitas dan daya saing. Beberapa pendekatan utama yang telah dikembangkan terkait dengan penelitian ini antara lain tentang Industri 4.0 dan *smart manufacturing* yang telah memperkenalkan integrasi antara IoT, AI dan Big Data, serta CPS untuk meningkatkan otomatisasi dan efisiensi produksi [12]. *Smart Manufacturing* menekankan pada penggunaan data *real-time* dan analisis berbasis AI untuk mengoptimalkan operasi manufaktur [1]. Selanjutnya tentang penerapan IoT dalam manufaktur yang memungkinkan konektivitas antar perangkat dalam lingkungan manufaktur, menciptakan sistem produksi yang lebih adaptif dan responsif terhadap perubahan permintaan pasar [13]. Pada studi sebelumnya telah diteliti penerapan sensor dan jaringan IoT untuk sistem monitoring proses produksi secara online dan real-time [2].

Penerapan AI dalam sistem produksi dapat digunakan untuk mengoptimalkan proses produksi melalui *machine learning*, *deep learning*, dan sistem berbasis data yang dapat mengidentifikasi pola dan meningkatkan efisiensi produksi [14]. Algoritme AI dapat digunakan untuk *demand forecasting*, penjadwalan produksi, dan pengelolaan rantai pasok secara dinamis [15]. *Social manufacturing* merupakan pendekatan baru yang memanfaatkan kolaborasi berbasis digital antara pelaku industri, pemasok, dan konsumen dalam proses produksi [16]. Platform berbasis *cloud* dan teknologi *crowdsourcing* telah diterapkan dalam *social manufacturing* untuk meningkatkan fleksibilitas dan inovasi produk [17].

Penelitian tentang pengembangan sistem manufaktur yang melibatkan lingkungan sosial telah dilakukan oleh banyak peneliti, antara lain penelitian yang dilakukan oleh Agote-Garrido et al., tentang eksplorasi konsep metabolisme sosial sebagai dasar pengembangan sistem sosioteknis dalam Industri 5.0. Penelitian tersebut menganalisis metode dan pendekatan yang ada untuk mengintegrasikan teknologi Industri 4.0 ke dalam proses manufaktur. Model ini menekankan pentingnya mempertimbangkan sistem sosioteknis untuk merancang sistem manufaktur yang berpusat pada manusia, berkelanjutan dan tangguh [18].

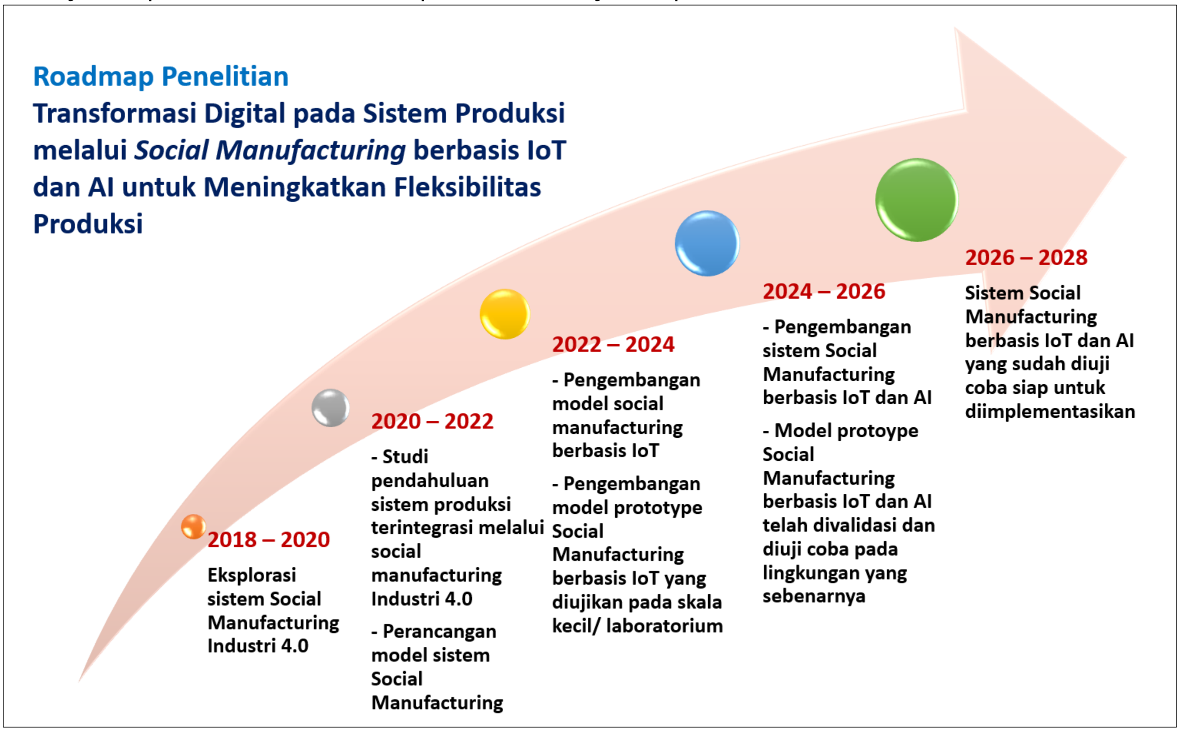
Penelitian yang dilakukan oleh Roso et al., yang mengeksplorasi tentang hubungan antara adopsi teknologi digital dan efisiensi operasional di perusahaan manufaktur skala kecil. Dengan menggunakan survei terhadap 150 perusahaan dan analisis regresi liner berganda, ditemukan korelasi positif signifikan antara adopsi teknologi (seperti otomatisasi, komputasi awan, dan analisis data) dan peningkatan kinerja operasional, termasuk kecepatan produksi, pengurangan biaya dan kualitas produk [8]. Penelitian yang dilakukan oleh Mardiana et al., tentang adopsi teknologi digital dan kecerdasan buatan oleh UMKM dalam konteks Revolusi Industri 4.0. Meskipun banyak UMKM telah beralih ke platform digital seperti *e-commerce*, adopsi kecerdasan buatan masih terbatas. Penelitian ini menekankan perlunya dukungan pemerintah dan sektor swasta dalam membantu UMKM mengadopsi teknologi terbaru untuk keberlanjutan bisnis [19].

Penelitian yang dilakukan Chavez et al., tentang eksplorasi apakah teknologi digital Industri 4.0 dapat meningkatkan efek produksi terhadap kinerja sosial. Dengan menggunakan data survei dari industri manufaktur di China, penelitian ini menemukan bahwa tiga dimensi produksi (internal, pelanggan, pemasok) memiliki efek positif signifikan terhadap kinerja sosial. Selain itu, kemajuan teknologi digital memperkuat hubungan ini, meskipun kontribusi terhadap kinerja sosial hanya marginal. Temuan ini memberikan panduan praktis bagi manajemen untuk mengintegrasikan teknologi dan aspek manusia dalam konteks transformasi digital [20]. Penelitian yang dilakukan oleh Xi et al., yang mengeksplorasi model evolusi tiga tahap untuk menganalisis dampak transformasi digital pada kinerja berkelanjutan perusahaan manufaktur. Hasil penelitian menunjukkan bahwa operasi digital dan teknologi digital secara signifikan meningkatkan kinerja ekonomi dan lingkungan. Temuan ini memberikan wawasan bagi perusahaan untuk mencapai pembangunan berkelanjutan melalui implementasi transformasi digital dan peningkatan kapasitas teknologi ini [21].

Berdasarkan penelitian-penelitian tersebut maka pada penelitian ini akan dilakukan pengembangan model *social manufacturing* berbasis IoT dan AI pada sistem produksi untuk meningkatkan fleksibilitas produksi. **Kebaruan** dalam penelitian ini adalah integrasi antara *social manufacturing*, IoT dan AI untuk menciptakan sistem produksi yang lebih fleksibel dan adaptif, dengan melibatkan SMR. Penelitian ini diharapkan dapat berkontribusi pada pengembangan sistem produksi yang lebih fleksibel, efisien dan berbasis kolaborasi digital.

5. Peta Jalan (*Road Map*) Penelitian

Peta jalan penelitian dari tim peneliti disajikan pada Gambar 3.



Gambar 3. Peta jalan penelitian

Penelitian yang akan dilakukan memasuki tahap ke-4 (2024 – 2026), yaitu pengembangan *prototype social manufacturing* berbasis IoT dan AI yang diterapkan di lingkungan yang sebenarnya, dan merupakan **kelanjutan** dari tahapan penelitian sebelumnya.

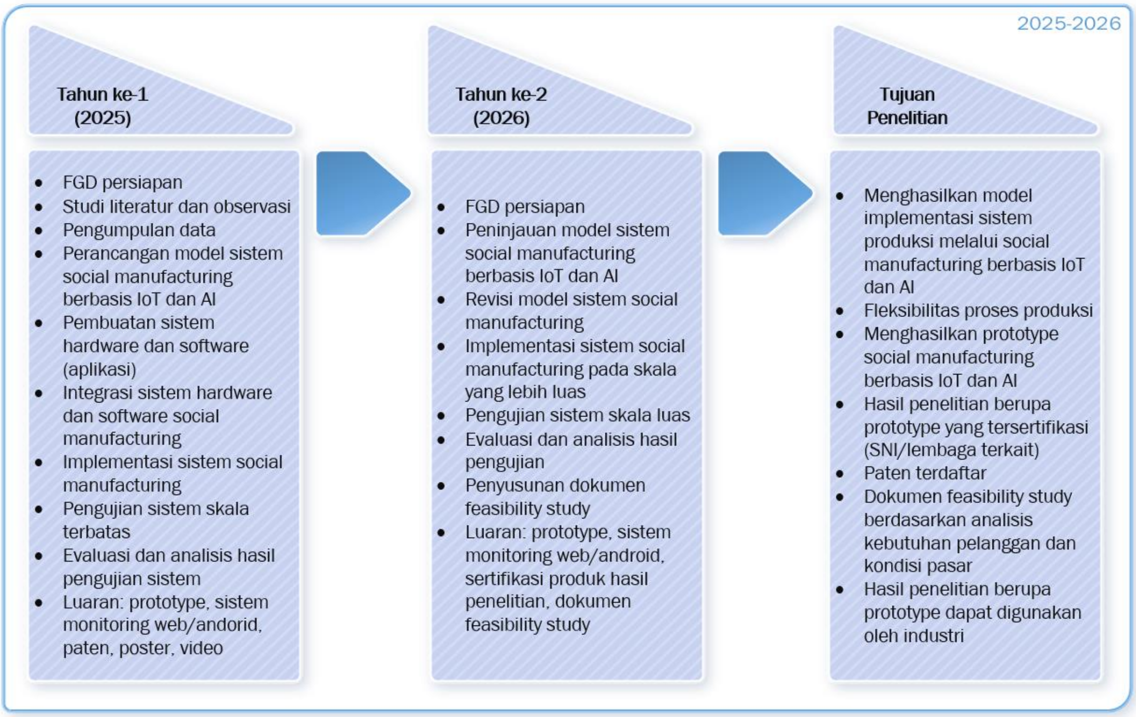
E. METODE

Isian metode atau cara untuk mencapai tujuan yang telah ditetapkan tidak lebih dari 1000 kata. Pada bagian metode wajib dilengkapi dengan diagram alir penelitian yang menggambarkan apa yang sudah dilaksanakan dan yang akan dikerjakan selama waktu yang diusulkan. Format diagram alir dapat berupa file JPG/PNG. Metode penelitian harus memuat sekurang-kurangnya prosedur penelitian, hasil yang diharapkan, indikator capaian yang ditargetkan, serta anggota tim/mitra yang bertanggung jawab pada setiap tahapan penelitian. Metode penelitian harus sejalan dengen Rencana Anggaran Biaya (RAB).

1. Tahapan Penelitian

Penelitian ini akan dilaksanakan dalam 2 (dua) tahun, yaitu tahun **2025** dan **2026**. Pada tahun **2025**, tahapan penelitian yang dilakukan antara lain studi literatur dan observasi, pengumpulan data, perancangan model, pembuatan *prototype* sistem *social manufacturing*, implementasi sistem, pengujian sistem pada skala terbatas, evaluasi dan analisis hasil pengujian, penyusunan draft paten sederhana.

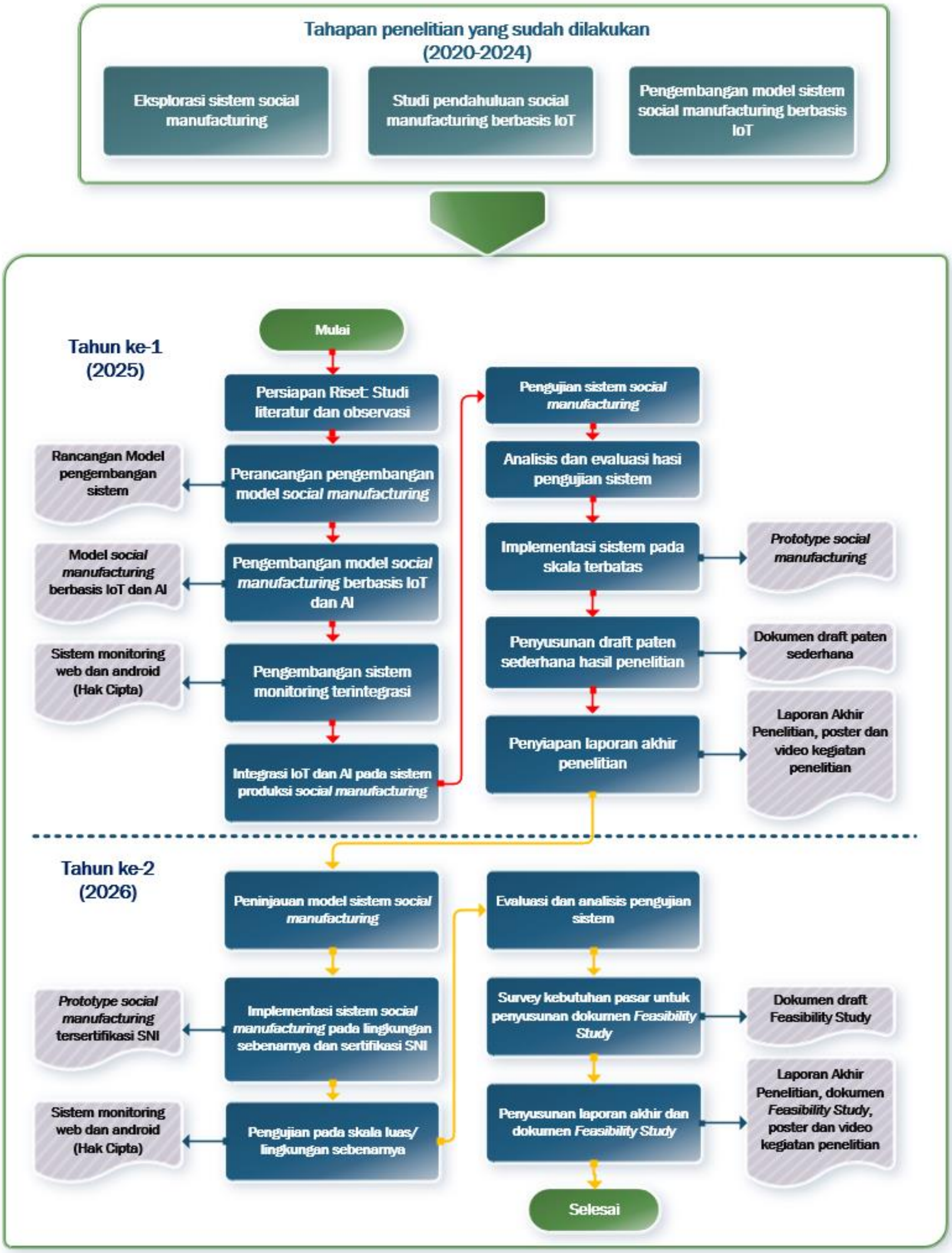
Pada tahun **2026**, tahapan penelitian yang dilakukan antara lain peninjauan model *social manufacturing*, implementasi *prototype* pada skala yang lebih luas, pengujian sistem, evaluasi dan analisis hasil pengujian, sertifikasi hasil penelitian dan penyusunan dokumen *feasibility study*. Tahapan penelitian keseluruhan disajikan pada Gambar 4.



Gambar 4. Tahapan penelitian selama dua tahun

Tahapan penyusunan dokumen *feasibility study* antara lain adalah mengidentifikasi dan perumusan ide produk, deskripsi produk, studi pasar untuk analisis kebutuhan industri, segmentasi pasar, serta analisis pesaing. Kemudian dilakukan studi teknis terkait desain sistem kebutuhan teknologi, dan rencana pengembangan *prototype*, studi keuangan, seperti biaya operasional, biaya perkiraan pengembangan awal, dan analisis kelayakan finansial, serta studi lingkungan sosial, seperti dampak sosial terkait kompetensi pekerja digital dan juga peluang kerja baru di bidang teknis.

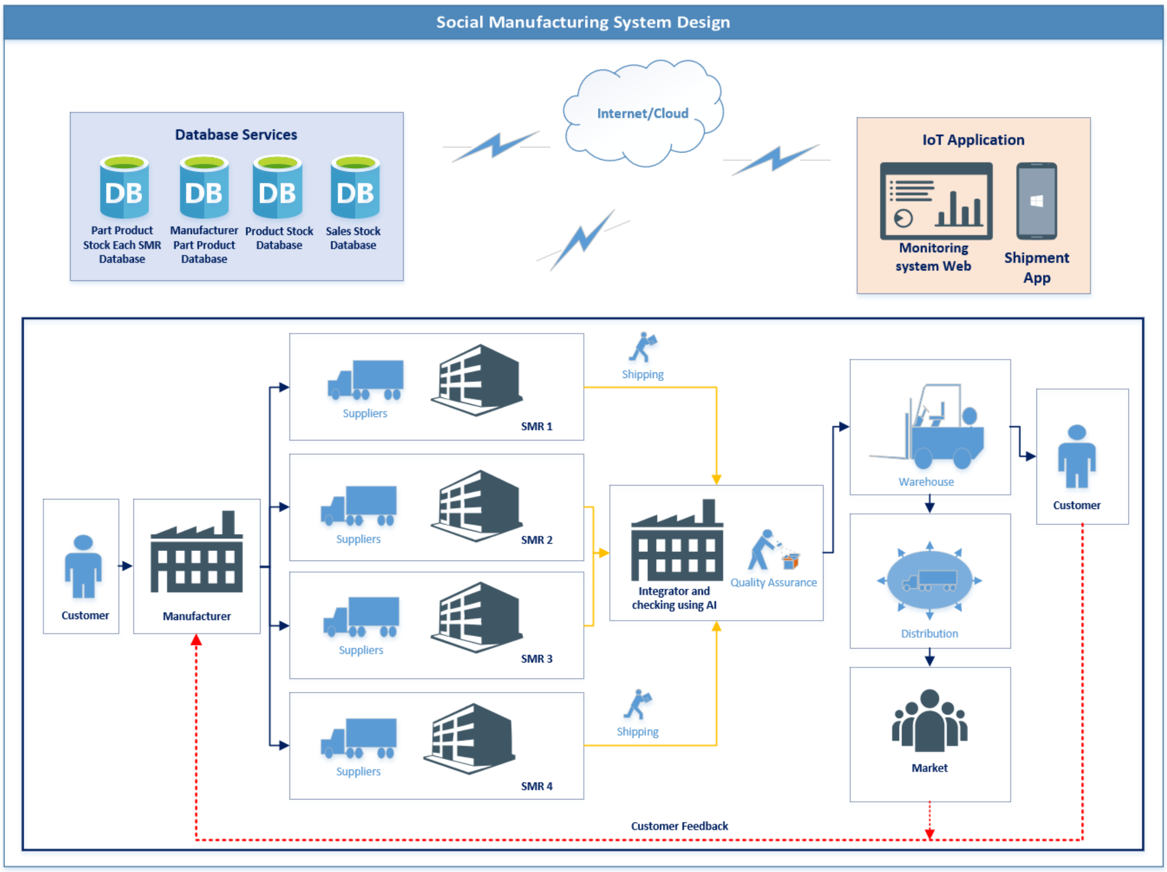
Detail **tahapan penelitian** yang akan dilakukan dan **luaran** pada tiap tahapan disajikan pada Gambar 5.



Gambar 5. *Flowchart* penelitian

Pengumpulan data dan perancangan model sistem *social manufacturing* dilakukan dengan cara identifikasi kebutuhan industri, perancangan dan pengembangan model *social manufacturing*, menentukan struktur kolaborasi antara produsen, pemasok, pelanggan dan stakeholder yang lain (SMR), simulasi dan validasi model *social manufacturing*, evaluasi dan penyempurnaan berdasar *feedback* dari industri. Implementasi sistem dimulai dari pembuatan sistem hardware dan software (aplikasi), kemudian mengintegrasikan keduanya menjadi sistem *social manufacturing* berbasis IoT dan AI.

Penelitian ini akan dilaksanakan di Kabupaten Sleman, dan melibatkan mitra pengguna dari Badan Perencanaan dan Pembangunan Daerah (Bappeda) Kabupaten Sleman. Hasil penelitian akan dijadikan objek percontohan untuk penerapan digitalisasi industri manufaktur di daerah Sleman. Desain sistem produksi melalui *social manufacturing* berbasis IoT dan AI untuk meningkatkan fleksibilitas produksi disajikan pada Gambar 6.



Gambar 6. Desain *social manufacturing* berbasis IoT dan AI

Gambar di atas menunjukkan desain sistem *social manufacturing* berbasis IoT dan AI yang mengintegrasikan berbagai komponen dalam proses manufaktur modern dengan dukungan teknologi IoT, *cloud computing* dan AI. Sistem ini dirancang untuk meningkatkan fleksibilitas dan kolaborasi dalam proses produksi berbasis digital.

Komponen utama pada desain sistem tersebut adalah:

a) Database

Sistem ini akan memiliki beberapa basis data utama yang mendukung operasional, yaitu:

- *Part Product Stock SMR Database*: menyimpan data stok material di setiap fasilitas produksi (SMR)
- *Manufacturer Part Product Database*: berisi informasi mengenai material yang diproduksi
- *Product Stock Database*: menyimpan data produk jadi yang tersedia dalam sistem
- *Sales Stock Database*: berisi informasi stok yang telah terjual atau siap dipasarkan

Semua database ini dihubungkan melalui *cloud*, sehingga dapat diakses secara *real-time* oleh semua pihak yang terlibat.

b) IoT Application

Sistem ini didukung oleh aplikasi IoT yaitu:

- Sistem monitoring berbasis web dan android: memantau status produksi dan logistik secara online melalui web dan android
- Sistem monitoring pengiriman barang (Shipment App)

c) Alur Produksi dan Distribusi

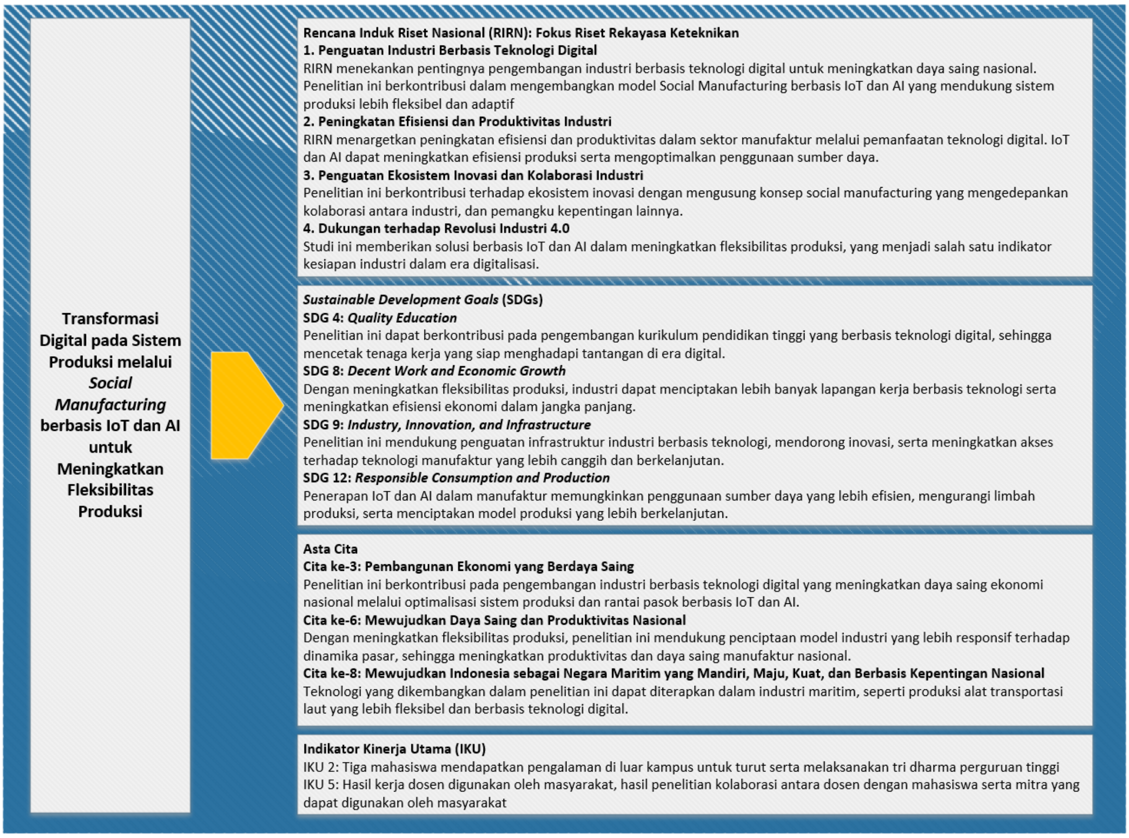
Alur produksi dan distribusi yaitu:

- Pelanggan memesan produk kepada produsen (*manufacturer*)
- Produsen mengalokasikan produksi ke beberapa SMR, yaitu fasilitas produksi yang berbasis kolaborasi sosial
- Setiap SMR mendapatkan bahan baku dari pemasok dan memproduksi komponen yang dibutuhkan
- Produk dari berbagai SMR dikirim ke Integrator, yang bertanggung jawab untuk pengecekan kualitas menggunakan AI (*image processing*) dan perakitan akhir
- Produk yang lolos uji dikirim ke gudang (*warehouse*) sebelum didistribusikan ke pelanggan dan pasar
- Sistem distribusi mengirim produk ke pelanggan melalui jaringan logistik yang efisien
- Feedback pelanggan dikumpulkan untuk analisis lebih lanjut dan memungkinkan peningkatan kualitas produk secara berkelanjutan

IoT memantau pergerakan barang, status produksi dan stok produk, sedangkan **AI mendukung pengambilan keputusan dan kontrol kualitas** yang lebih cepat dan akurat.

2. Kesesuaian dengan Fokus Riset (RIRN), Asta Cita, SDGs dan IKU

Penelitian ini telah sesuai dengan fokus riset/Rencana Induk Riset Nasional (RIRN), Asta Cita, *Sustainable Development Goals* (SDGs) dan Indikator Kinerja Utama (IKU) perguruan tinggi. Keterkaitan tersebut disajikan pada Gambar 7.

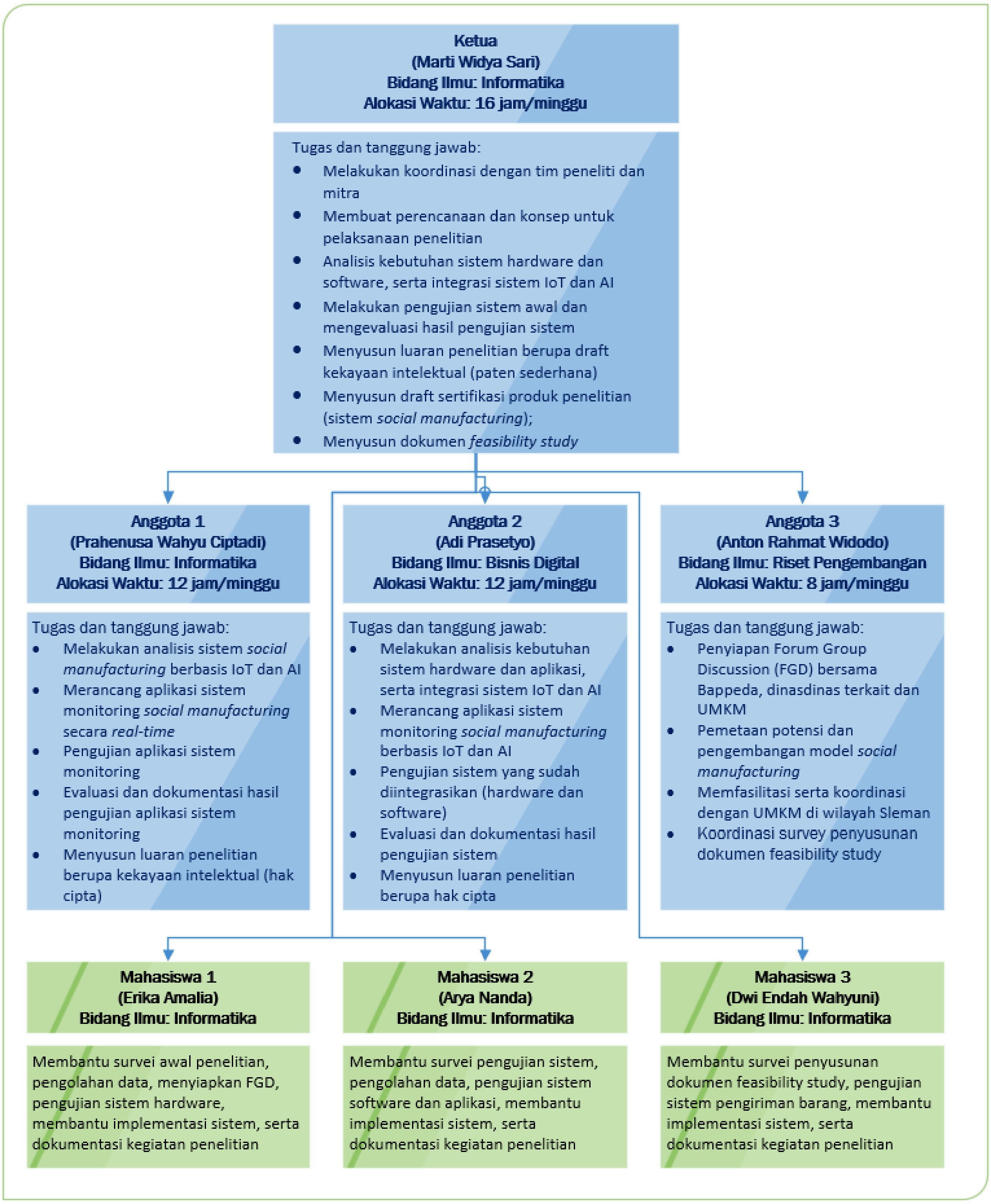


Gambar 7. Kesesuaian penelitian dengan RIRN, SDGs, Asta Cita, dan IKU

Pada penelitian ini, fokus riset sesuai dengan RIRN adalah Produk Rekayasa Keteknikan, antara lain melalui penguatan industri berbasis teknologi digital, peningkatan efisiensi dan produktivitas industri, penguatan ekosistem inovasi dan kolaborasi industri, dan dukungan terhadap Revolusi Industri 4.0. Kemudian untuk SDGs, meliputi SDG 4 kualitas pendidikan, SDG 8 pertumbuhan ekonomi, SDG 9 industri, inovasi dan infrastruktur, dan SDG 12 konsumsi dan produksi yang bertanggung jawab. Selanjutnya terkait dengan Asta Cita yaitu cita ke-3, cita ke-6 dan cita ke-8. Dan untuk IKU terdapat 2 indikator yaitu IKU 2 dan IKU 5.

3. Pembagian Tugas Tim Peneliti

Pembagian tugas dan tanggung jawab tim peneliti disajikan pada Gambar 8.



Gambar 8. Pembagian Tugas Tim Peneliti

Setiap kegiatan penelitian akan melibatkan tim peneliti, mahasiswa yang membantu penelitian dan juga melibatkan mitra pengguna secara langsung.

F. HASIL YANG DIHARAPKAN

Jelaskan hasil yang diharapkan atau luaran yang dijanjikan dari penelitian

Hasil yang diharapkan

Luaran dan target capaian yang diharapkan dalam pelaksanaan penelitian selama 2 tahun ditampilkan pada Tabel 1 berikut.

Tabel 1. Luaran dan Target Capaian

No	Jenis Luaran	Target Capaian	Keterangan
	Luaran Tahun ke-1		
	Luaran Wajib		
1	Prototipe sistem *social manufacturing* berbasis IoT dan AI	1	Produk
2	Kekayaan intelektual berupa Paten Sederhana	1	Terdaftar
	Luaran Tambahan		
1	Aplikasi sistem monitoring *social manufacturing* berbasis IoT dan AI berbasis web	1	Produk
2	Aplikasi sistem monitoring *social manufacturing* berbasis IoT dan AI berbasis android	1	Produk
3	Aplikasi pengiriman produk/material dari SMR	1	Produk
4	Kekayaan intelektual berupa Hak Cipta	2	Granted
5	Poster hasil penelitian	1	Produk
6	Video kegiatan penelitian	1	Produk
	Luaran Tahun ke-2		
	Luaran Wajib		
1	Prototipe sistem *social manufacturing* berbasis IoT dan AI yang sudah berstandar SNI	1	Produk
2	Dokumen *Feasibility Study*	1	Granted
	Luaran Tambahan		
1	Aplikasi sistem monitoring social manufacturing berbasis IoT dan AI berbasis web	1	Produk
2	Aplikasi sistem monitoring *social manufacturing* berbasis IoT dan AI berbasis android	1	Produk
3	Aplikasi pengiriman produk/material dari SMR	1	Produk
4	Kekayaan intelektual berupa Hak Cipta	2	Granted
5	Poster hasil penelitian	1	Produk
6	Video kegiatan penelitian	1	Produk

Tahun ke-1

a) Menghasilkan *prototype* yang telah diuji pada lingkungan terbatas, yang meliputi integrasi IoT, dukungan AI, konektivitas *cloud*, dan antarmuka untuk interaksi pengguna/operator yang bersifat *user-friendly*
b) Menghasilkan sistem monitoring *social manufacturing* berbasis web, yang memungkinkan pengguna untuk mengakses informasi proses produksi secara *real-time* dari *browser* tanpa harus menginstal aplikasi tambahan
c) Menghasilkan sistem monitoring *social manufacturing* berbasis android, yang memungkinkan akses ke monitoring sistem produksi dari perangkat *mobile/smartphone*
d) Menghasilkan aplikasi pengiriman produk/material, yang berfungsi sebagai sistem pelacakan untuk memastikan bahwa barang dapat dikirim dengan efisien dan *real-time* dalam sistem *social manufacturing*
e) Menghasilkan paten sederhana
f) Menghasilkan kekayaan intelektual berupa hak cipta (2 produk)
g) Poster hasil penelitian
h) Video kegiatan penelitian

Tahun ke-2

a) Menghasilkan *prototype* yang telah diuji di lingkungan sebenarnya dan mendapatkan sertifikasi hasil penelitian (SNI/lembaga terkait)
b) Menghasilkan sistem monitoring *social manufacturing* berbasis web yang lebih matang
c) Menghasilkan sistem monitoring *social manufacturing* berbasis android yang lebih stabil
d) Menghasilkan aplikasi pengiriman produk/material yang lebih update
e) Menghasilkan kekayaan intelektual berupa hak cipta (2 produk)
f) Menghasilkan dokumen *Feasibility Study* yang berisi analisis kelayakan implementasi *social manufacturing* berbasis IoT dan AI dalam industri, mencakup aspek teknis, ekonomi dan dampak digitalisasi
g) Menghasilkan poster ilmiah sebagai bentuk diseminasi penelitian
h) Menghasilkan video dokumentasi yang menampilkan pengujian sistem pada lingkungan yang sebenarnya

Dengan target luaran tersebut, penelitian ini diharapkan dapat memberikan kontribusi nyata dalam pengembangan teknologi manufaktur berbasis digital, serta mendukung inovasi dan fleksibilitas dalam sistem produksi.

G. JADWAL PENELITIAN

Jadwal penelitian disusun berdasarkan pelaksanaan penelitian dan disesuaikan berdasarkan lama tahun pelaksanaan penelitian

Tahun ke-1

No	Nama Kegiatan	Bulan											
		1	2	3	4	5	6	7	8	9	10	11	12
1	FGD Persiapan Riset					v	v						
2	Studi literatur dan pengumpulan data					v	v						
3	Perancangan model *social manufacturing* berbasis IoT dan AI						v	v					
4	Perancangan pengembangan prototype sistem *social*						v	v					

	manufacturing berbasis IoT dan AI												
5	Analisis kebutuhan perangkat keras dan perangkat lunak						v	v					
6	Pembuatan prototype hardware sistem *social manufacturing*						v	v	v				
7	Pembuatan sistem monitoring *social manufacturing* (Web)							v	v				
8	Pembuatan sistem monitoring *social manufacturing* (Aplikasi Android)							v	v				
9	Pengembangan *prototype* sistem hardware (perangkat IoT)							v	v				
10	Pengembangan sistem monitoring terintegrasi							v	v				
11	Integrasi sistem IoT dan AI							v	v	v			
12	Pengujian model sistem pada skala yang sebenarnya								v	v			
13	Evaluasi pengujian model sistem pada skala yang sebenarnya								v	v			
14	Lanjutan pengujian model sistem pada skala yang sebenarnya								v	v			
15	Analisis dan dokumentasi hasil pengujian model sistem								v	v			
16	Penyusunan draft paten sederhana								v	v	v		
17	Konsultasi ahli draft paten sederhana									v	v		
18	Penyiapan dokumen untuk pendaftaran paten sederhana									v	v		
19	Proses pendaftaran paten sederhana									v	v		
20	Evaluasi proses penelitian dengan mitra pengguna									v	v		
21	Penyusunan laporan akhir penelitian										v	v	v

Tahun ke-2

No	Nama Kegiatan	Bulan											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	FGD Persiapan Riset	v	v	v									

2	FGD validasi model oleh ahli			v	v								
3	Revisi model sistem *social manufacturing*			v	v	v							
4	Uji coba model dalam skala terbatas				v	v							
5	Revisi model pasca uji coba skala terbatas					v	v						
6	Uji coba skala luas					v	v	v					
7	Revisi model pasca uji coba lingkungan sebenarnya						v	v					
8	Penyusunan dokumen sertifikasi *prototype* hasil penelitian						v	v					
9	Pengujian *prototype* hasil penelitian						v	v	v				
10	Proses penilaian *prototype* hasil penelitian oleh Bappeda dan dinas terkait						v	v	v				
11	Pendaftaran dan pengajuan sertifikasi *prototype* hasil penelitian							v	v				
12	Penyusunan luaran wajib dokumen *feasibility study*							v	v				
13	Revisi dokumen *feasibility study*							v	v	v			
14	Pengujian dokumen *feasibility study* melalui survey dan observasi ke industri manufaktur								v	v			
15	Penyusunan poster hasil penelitian								v	v			
16	Pembuatan video kegiatan penelitian								v	v	v		
17	Dokumentasi hasil *feasibility study*									v	v	v	
18	Penyusunan laporan akhir tahun ke-2										v	v	v

H. DAFTAR PUSTAKA

Sitasi disusun dan ditulis berdasarkan sistem nomor sesuai dengan urutan pengutipan. Hanya pustaka yang disitasi pada usulan penelitian yang dicantumkan dalam Daftar Pustaka.

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INTEGRATED PRODUCTION SYSTEM ON SOCIAL MANUFACTURING: A SIMULATION STUDY

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Abstract:
Today, the manufacturing industry must adapt to dynamic customer needs, changing from time to time following market trends. So that the production process in manufacturing requires adjustments, one of which is by forming social manufacturing. This study aims to create an integrated production system model based on social manufacturing, which involves several Socialized Manufacturing Resources (SMR) as manufacturing resources that are socialized to produce a product. The methods used are field observation, literature study, design of a social manufacturing-based production system model, model simulation using ProModel software, and analysis of model simulation results. In this study, the simulation involves four SMRs, each of which makes a part that has been given specifications by the manufacturer based on customer requests. The product produced is the Sanitation Chamber, which is equipped with a control system to monitor reading data via the internet. The model simulation uses the Pro Model software and analyzes resource use, location utilization, and resource costs.

Key words: *social manufacturing, integrated production systems, simulation study, ProModel*

INTRODUCTION

Manufacturing systems, information and management technology, and manufacturing's social environment have developed rapidly in recent years. It has changed a lot, such as increasing global market competition, diversity of customer demands, and so on [1]. Currently, the manufacturing industry is required to meet customer needs that are very diverse and can change at any time and follow specific trends [2]. The Industrial Age 4.0 allows the production system to increase flexibility in making a product customized according to customer needs [3], commonly referred to as product personalization [4]. Mass personalization of products with diverse customer needs and dynamic online market trends have encouraged manufacturers to have various manufacturing capabilities, especially those that appear for personalization or innovative products [3]. But sustainable investment to meet these needs is too large and not profitable for producers' strategic development [2]. Many companies implement an outsourcing/crowdsourcing system to reduce operating costs to react quickly to dynamic markets [5, 6]. With the rapid development of the internet and information technology today [7], interaction, and information between service providers and communities have become easier [8]. On the other hand, time-varying customer demands and production disruptions force manufacturers to increase flexibility in the production process [2].

Social manufacturing involves stakeholders, customers who access products/services via the internet, social manufacturing resources (SMR), and applications used through social media or applications on mobile devices [6, 9]. As a new form of manufacturing, social manufacturing shows the complexity between social-cyber, as the source of manufacturing services is social. Doing so can exacerbate uncertainty and dynamic supply services [10]. The merger of the Cyber-Physical System (CPS) with social media produces a social manufacturing and basic theory for production organizations in the future [11, 12]. At the core of social manufacturing, three aspects are configuration, operation, and management perspectives, which are expected to transform production modes and social innovation [6]. Social manufacturing is proposed as an innovative manufacturing solution for product personalization customization [1, 13]. Besides, social manufacturing is considered to realize "from mind to product" to meet customer demand. The future challenge is to add applications and the prospect of personalized products and services for customers [14]. The social manufacturing community is formed to meet every customer need by grouping small industries according to resources. Every request from customers can be resolved together [15]. Product costs and delivery time are indicators for allocating product orders in the social manufacturing community that has been formed [16].

Facing the challenge of mass demand for product personalization, the manufacturing model has developed into social manufacturing [15], where stakeholders who have manufacturing resources share, for example, small medium-size enterprises (SMEs), logistics service providers, and factory warehouse providers [17], forming a community, referred to as SMR [18, 19], based on social media collaborating with manufacturers to produce a product [20].

Many SMEs and individuals have sprung up with socialized resources and participated in different segments [21]. The small and medium industrial community provides various service-oriented capabilities to meet customer demands [22]. The trend of small and medium industrial communities forming new communities to produce a product has changed the paradigm of manual and automatic manufacturing systems and production modes [12]. This study aims to design an integrated production system model based on social manufacturing, then simulate the existing model using Pro Model software. This integrated production system model involves several SMEs, which form a social manufacturing system and produce a medical device, namely the Sanitation Chamber, to prevent the transmission of COVID-19.

LITERATURE REVIEW

Social Manufacturing Concept

Social Manufacturing is a special production process based on outsourcing and crowdsourcing [5], manufacturing services based on mass socialization in independent organizations, and service orientation towards the mass individualization paradigm [21, 23]. Social Manufacturing mode integrates mass personalization on manufacturing, information interconnection, and product services [15]. Many advanced manufacturing modes have been proposed in recent years, and the multitude of providers, being one of the most visible changes. Development on Flexible Manufacturing [24, 25], Cloud Manufacturing [1], Manufacturing Grid [26], Collaborative Manufacturing [27, 28], Networked Manufacturing [29], and Virtual Enterprise [30, 31, 32], which emphasize collaboration and interconnection between manufacturers. The manufacturing community consists of many prosumers who share the same interests and tasks in a social manufacturing system. Different users can outsource or add specific tasks from the relevant manufacturing community according to their needs or abilities and then form a virtual manufacturing environment or solutions to complete the manufacturing tasks that result in a product [21]. All manufacturing communities involved in the entire life cycle will support social computing, service-oriented technology, and advanced computing technology [33]. Multiple manufacturing resources and capabilities are virtualized and collected to proactively push into demand knowledge-based using social computing and service-oriented technology. However, there are differences in the manufacturing process, including resource type, resource integration, resource sharing, sharing production coordination, resource management, product life cycle information sharing, information technology used, and their characteristics, as shown in Table 1.

Table 1
The comparison of manufacturing paradigms

Items	**Flexible Manufacturing** [24, 25]	**Virtual Enterprise** [30, 31, 32]	**Manufacturing Grid** [26]	**Cloud Manufacturing** [1, 34]	**Collaborative Manufacturing** [27, 28]	**Networked Manufacturing** [29]	**Social Manufacturing** [15, 16, 21]
Type of resources	Manufacturing resources	Enterprises	Enterprises	Manufacturing resources	Enterprises	Enterprises	Socialized manufacturing resources (SMRs)
Integration of resources	Information and process	Manufacturing resources, data/information, etc.	Manufacturing resources, computing resources, etc.	Manufacturing resources and abilities	Manufacturing resources and abilities	Manufacturing resources and abilities	Resources form product life cycle
Sharing of resource and coordination of production	Within an enterprise	Among several enterprises	Among mass enterprises	Among several enterprises	Based on grid	Among several enterprises	Among the whole society
Management of resources	Centralized	Centralized	Centralized	Centralized	Semi-decentralized	Centralized	Semi-decentralized, self-organized
The Life cycle of product and information sharing	Inter-enterprise sharing	Partially sharing	Partially sharing	Partially sharing	Based on grid	Information sharing	Full-scale sharing
Information technology-enabled	Computer-aided technology	ICT, concurrent engineering	Grid computing, agent, web service	Cloud computing, IoT, RFID, sensor network, etc.	WAN environment	Internet	The Social network, cloud computing, big data, industry 4.0, etc.
Manufacturing Characteristics	Flexibility, based on modularity	Agility, resource sharing, efficiency	Flexibility, agility, resource sharing, cost-saving	Flexibility, agility, resource sharing, on-demand, value-added service	Flexibility, resource sharing	Flexibility, information sharing	Flexibility, agility, value-added service, social innovation

Socialized Manufacturing Resource

Socialized Manufacturing Research (SMR) is a resource owned by stakeholders in social manufacturing systems, such as small-medium enterprises (SMEs), smart factories, logistics service providers, and public warehouse providers, forming a social media-based community with producers to collaborate to produce products [2]. With the development of the mobile internet and social networks, interaction and sharing of information among service providers have become more accessible. Social manufacturing is interrelated by a contractual relationship between the manufacturer and its partners, while the production sequence relationships are built among SMR providers [16, 35]. Many SMRs with decentralized, adaptive, and self-organizing characteristics began to group as communities to provide specialized manufacturing services to prosumers [36]. SMR communities are complex, dynamic autonomous systems to co-create individualized products and services [6].

RESEARCH METHODS

The methods used in this study were conducting field observations, literature studies, designing a social manufacturing system model, testing the system, and analyzing the test results. Field observations carried out by the research team are essential to determine the development of the spread of COVID-19. The observation process that has been carried out is by looking at data on the internet about the story of the COVID-19 pandemic, the use of the Sanitation Chamber to prevent virus transmission, and which locations have used the Sanitation Chamber.

This research takes a case study on an integrated production process based on social manufacturing to produce a medical device in a Sanitation Chamber. During this pandemic, the need for medical devices in a sanitation chamber is urgently needed to prevent COVID-19 transmission. As demand increases, production can be carried out quickly and distributed to various public service facilities. Based on this background, this research will develop a social manufacturing-based sanitation chamber production system involving SMRs. Field observations and literature studies have been carried out and involved several SMRs. The following process compiles a social manufacturing system model and then simulates the model using ProModel software.

System Design

The design of the social manufacturing system in this study is presented in Fig. 1, which involves four SMRs to make a product. Each SMR makes the components that make up the product, according to the specifications provided by the Manufacturer. After each component is ready, it is then sent to the integrator for the installation and assembly process.

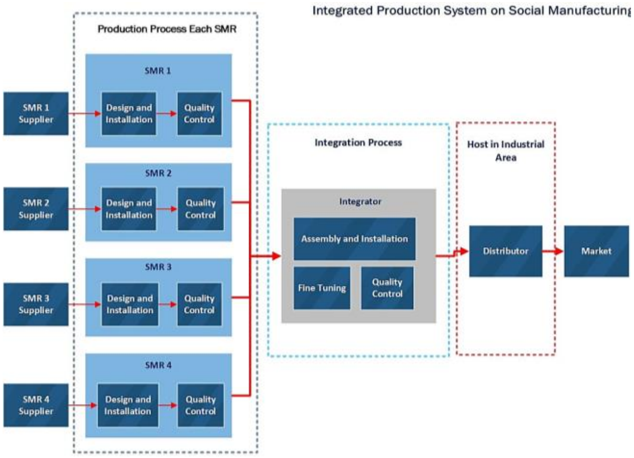

Fig. 1 Social Manufacturing system design

In the design of this social manufacturing system, there are two production processes, namely the component production process at SMR and the final product production process at the Integrator. Each SMR involved already has a supplier for component manufacturing materials following the specifications required to manufacture product components. After each SMR component is completed, they are then sent to the Integrator for the assembly process into the final product. Furthermore, the final product will be brought to the distributor to be marketed to the market.

System Model Simulation

The social manufacturing system model simulation was carried out using the ProModel software, with the steps presented in Fig. 2.

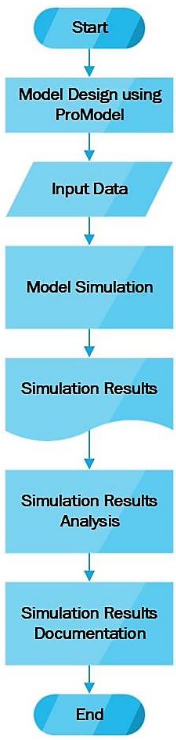

Fig. 2 System model simulation flowchart

The first step is to create a model of the social manufacturing system in the ProModel software. Then, input data for the social manufacturing system, such as the number of SMRs involved, the assumption of working hours per day, the cost required to make a part for each SMR and the placement of the SMR locations, because it will determine the transportation costs. Furthermore, the simulation can be done through the Run button on the ProModel, and then the results can immediately be seen on the monitor in the form of tables and graphs.

The simulation results in the form of graphs can be seen immediately after the Run process. Furthermore, the simulation results are analyzed to obtain appropriate research data, then documented.

RESULTS AND DISCUSSION

The difference between the social manufacturing system in this study and Ding's research is the social manufacturing system model. In research conducted by [2], a social manufacturing system was created by involving several SMRs with far apart locations, to produce printer machines. Each SMR completes a part then is continued and combined by the next SMR until the product is finished and returned to the manufacturer. In this study, the simulation involves four SMRs, each of which makes a part that has been given specifications by the manufacturer based on customer requests. The product produced is the Sanitation Chamber, which is equipped with a control system to monitor reading data via the internet.

In this simulation study, four SMRs produced a Sanitation Chamber, namely PT ATMI, CV Bisri, CV Alfan, and CV Ekrar. PT ATMI is tasked with making body frames made from stainless steel, and CV Bisri is in charge of designing and installing the sprayer, CV Alfan is in order of designing and installing the controller. CV Ekrar is in charge of developing an internet of things (IoT) based monitoring system application. The system model that has been made is presented in Fig. 3. Each SMR designs product components at their respective locations, then after the components are finished, they are assembled and integrated with other parts at the PSE. We got all information about the production process, such as material supplier, production time, and production costing, through field observations and in-depth interviews with the owners.

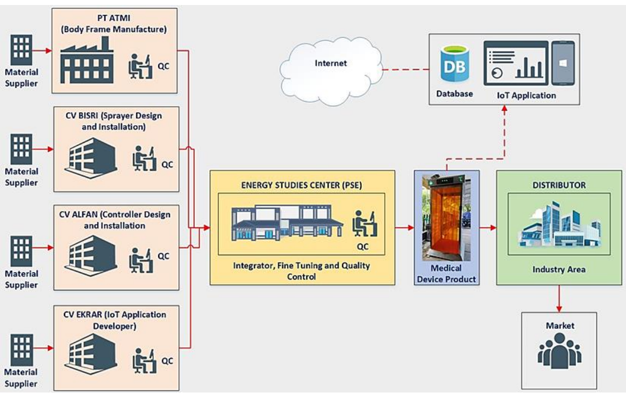

Fig. 3 Social Manufacturing System Model

The process of designing and installing components in each SME can be done in parallel, so there is no waiting for one of the components to be completed. The initial process starts with the Center for Energy Studies (PSE). We design an integrated production system to produce a Sanitation Chamber, starting from selecting SMEs, device design, what raw materials are needed, and what costs are required, including the estimated total time needed to make this product. Then, we sent the device image's design to the SMEs involved being executed immediately. PT ATMI makes the body frame for the Sanitation Chamber using stainless steel base material to ensure that this device can last longer and be easier to clean. In making this body frame, PT ATMI took about two weeks. For information, that PT ATMI has good competence in terms of making frames. PT ATMI's business location is in Solo, Central Java, about 64 km from Yogyakarta. Therefore, communication and coordination are carried out via WhatsApp and mobile phones.

Furthermore, CV Bisri designed the sprayer installation on the body frame by the specifications of the drawings. The production process of this sprayer takes about a week. Then, the sprayer components were brought to PSE for the integration process with the body frame. CV Alfan carried out the control system's design and installation according to the specifications we have provided. The control system that has been completed is then brought to PSE to be assembled and integrated with other parts. All hardware requirements were met, then the device was built and integrated with other components. Quality control is also carried out to test the feasibility of the devices that have been made. To monitor the results of temperature measurements at the Sanitation Chamber, an Android-based application was created by CV Ekrar so that the results can be watched anywhere. The simulation results using Pro Model software are presented in Table 2.

Table 2 presents data on the scheduled time for each production process in hours (HR). The average time it takes to complete the product is 252.70 hours. The body frame's design and installation process have the highest load time, which takes 528 hours. The lowest load time is in the fine-tuning and rejecting warehouse processes, which is 114 hours. Percent Empty means the percentage of the production system actively. The smaller the percentage value, meaning that the system does a lot of work in a specific time, and vice versa if the percentage value is higher, it indicates that the system is idle. Percent Occupied shows the level of use of each part in an integrated production system. In Table 2, it is shown that the highest percentage level of use is 90.04% in the body frame manufacturing process, and the lowest level of use is 3.72% in the sprayer installation process. There are four entities in this integrated production process, namely controller, sprayer, IoT application, and body frame.

Table 2
The results of Location States Multi from Pro Model software

Name	Scheduled Time (HR)	% Empty	% Part Occupied	% Full	% Down
Controller Supplier (1)	165.03	65.4441	34.56	0	0
Sprayer Supplier (2)	114.69	95.30382	4.7	0	0
IoT Application Supplier (3)	114.69	95.30382	4.7	0	0
Raw Material Supplier (4)	354	17.28993	82.71	0	0
Design Installation 1	234	41.10704	52.49	6.399003	0
Design Installation 2	180	60.26455	3.72	36.01706	0
Design Installation 3	318	24.67805	24.6	50.72544	0
Design Installation 4	528	9.956708	90.04	0	0
Quality Control 1	304	22.76002	77.24	0	0
Quality Control 2	306	21.25817	70.9	7.843137	0
Quality Control 3	456	10.63074	84.1	5.274123	0
Quality Control 4	314.1	23.62305	76.38	0	0
Assembly Installation	146	74.10959	25.89	0	0
Fine Tunning	114	94.73684	5.26	0	0
Final Quality Control	222	35.13514	64.86	0	0
Distributor	318	25.25157	74.75	0	0
Market	127.5	100	0	0	0
Reject Warehouse	114	100	0	0	0
Joint 1 2	510	5.676471	94.32	0	0
Joint 3 4	114	94.47368	5.53	0	0

The simulation results for each entity's activities are presented in Fig. 4, which shows the system's current quality, the average time in the system, the average time in move logic, average time waiting, the average time in operation, and average time blocked. The average time in the system is 28965 minutes.

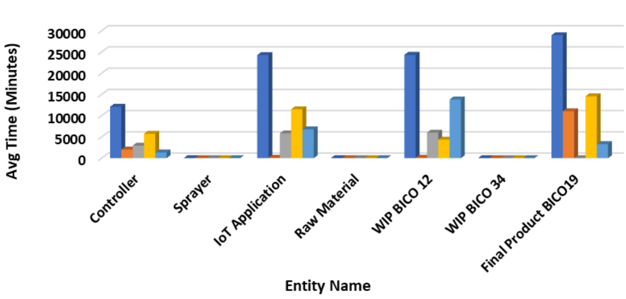

Fig. 4 Simulation results for Entity Activity

The average time in move logic is 11054.03 minutes. The average time waiting is 6 minutes. The average time in operation is 14580 minutes, and the average time block is 3324.97, in the final product BICO-19. Fig. 5 displays entity states for the controller, sprayer, IoT application, and raw material of body frame, showing the percentages in move logic, waiting, operation, and block.
The average value of the move logic percentage is 7.98%, the waiting percentage is 10.47%, the operation percentage is 23.34%, and the blocked percentage is 15.36%.

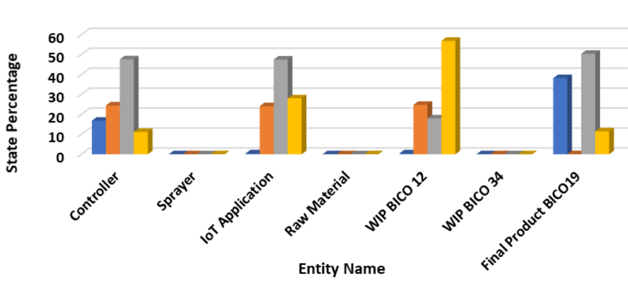

Fig. 5 Simulation results for Entity States

Furthermore, location utilization in an integrated production system is presented in Fig. 6. The highest location utilization is 59.78% for design and installation 3 (IoT application), while the lowest is 0.88% for fine-tuning.

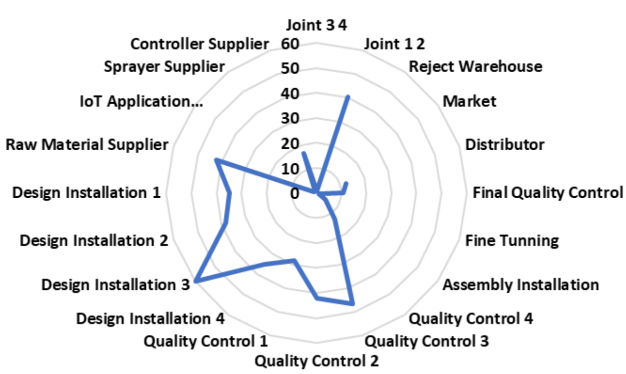

Fig. 6 Location Utilization

The use of resources for transporters and inspectors consists of the number of units, scheduled time (hour), number of times used, average time per usage (minutes), average time travel to use (minutes), as shown in Fig. 7.

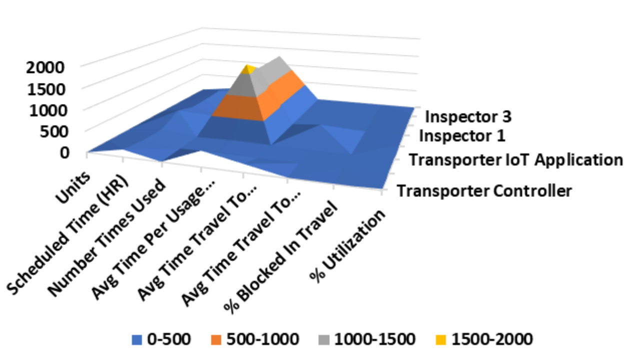

Fig. 7 Resources simulation results

The use of resources for transporters and inspectors consists of the number of units, scheduled time (hour), number of times used, average time per usage (minutes), average time travel to use (minutes), as shown in Fig. 7. The average value of scheduled time for transporters was 189.79 hours, and the average value for inspectors was 202.46 hours. The highest value of Average time per usage is 1714.29 minutes in raw material of body frame production, and the average time per usage value of all transporters is 535.71 minutes. The average time per usage for inspectors is 1080 minutes. The average time travel to use transporters is 53.75 minutes, while for the inspectors, it

is 0 minutes because they did not move anywhere. The average travel time to park for transporters is 91.59 minutes, while for inspectors, it is 0 minutes because they do not travel; they only work at the production site.
Furthermore, the percentage of utilization in transporters is 21.79%, and for inspectors is 46.69%. The rate of blocked travel is 0% because overall, the production process is running as planned. The transporter value for the scheduled time on the body frame's raw material is the highest, 353.17 hours because the distance from the production location is far from the PSE assembly site. Then, the estimated resource costs for transporters and inspectors are presented in Table 3. Determination of the cost of each resource in each SME based on the estimated real needs to produce a sanitation chamber product. The highest percentage of usage cost was 37.43% for the transporter for raw material of body frame, with a total price of around 180 USD, and the portion of the total cost was 31.29%.

Table 3
Resource costing

Name	Units	Nonuse Cost Dollars	% Nonuse Cost	Usage Cost Dollars	% Usage Cost	Total Cost Dollars	% Total Cost
Transporter Controller	1	0	0	107.1	22.2763	107.1	18.6185
Transporter Sprayer	1	0	0	42.84	8.91052	42.84	7.447402
Transporter IoT Application	1	0	0	42.84	8.91052	42.84	7.447402
Transporter Raw Material	1	0	0	180	37.43916	180	31.2916
Inspector 1	1	19.0601	20.17922	36	7.487832	55.0601	9.571774
Inspector 2	1	20.7625	21.98156	36	7.487832	56.7625	9.867721
Inspector 3	1	26.1315	27.66585	36	7.487832	62.1315	10.80109
Inspector 4	1	28.5	30.17337	0	0	28.5	4.954504

Most of the production needs were in the body frame's manufacture because the primary materials used are excellent, made of stainless steel, so the price is high. Meanwhile, for the inspector's cost, the highest value is the inspector 3, 62.13 USD with a total cost percentage is 10.80%, namely in making IoT applications, which require a lot of services rather than raw materials. This IoT application is connected to a modem in the control system connected to the internet to access temperature measurement data anywhere.

CONCLUSION

Simulation of an integrated production system model is essential because it can measure the actual system to be built. In this research, a framework design and integrated production system model in social manufacturing have involved four SMEs in producing a medical device in a sanitation chamber. Based on the literature [2, 6, 35], in this social manufacturing-based production system, reaching an agreement between the manager and the SMEs involved is carried out by direct discussion and communication so that all tasks are carried out based on the trust of each stakeholder. The total time needed to produce a sanitation chamber is around 30 days, with eight working hours per day, so the working hour is not counted as complete 24 hours. In this research, only model design and simulation were carried out. Through the production of this Sanitation Chamber, it is hoped that it can reduce the risk of transmission of the COVID-19 virus. As discussed in Nicola's research, the transmission of the COVID-19 virus cannot be avoided [37], but at least we can minimize its transmission by using masks, spraying disinfectants, using sanitation chambers, etc. Some things can still be improved for further study with different methods, such as making optimization using mathematical models, discussing production cost problems, and the effectiveness of SMEs' involvement in social manufacturing systems. Researchers can also compare conventional production systems (non-social manufacturing) in factories with an integrated production system based on social manufacturing.

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SOCIAL MANUFACTURING ON INTEGRATED PRODUCTION SYSTEM: A SYSTEMATIC LITERATURE REVIEW

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Abstract:
Currently, the development of information technology in all fields is very rapid, including in the manufacturing sector, thus making the social environment of manufacturing change a lot. Traditional manufacturing research focuses on applying technology, such as production models, supplier arrangements, automation, advanced machines in the manufacturing industry, etc. Global competition and increasingly diverse customer demands are a phenomenon that occurs today. Social manufacturing is a new distributed, collaborative, and intelligent manufacturing, that every consumer can participate in the entire process of product design, manufacture, and even marketing. This study aims to examine the development of social manufacturing systems and the latest research in social manufacturing. The method used is to review the latest papers related to social manufacturing that provide a new paradigm for the manufacturing industry, then map based on the concepts, frameworks, and technologies used. The results of this review paper are in the form of mapping research papers taken from the database of a reputable international journal, Scopus. The mapping includes data on the author, co-author, terms on social manufacturing paper, year of publication, type of document and publisher. This systematic literature review can be one of the references for basic research on social manufacturing.

Key words: *social manufacturing, product personalization, review, manufacturing enterprise*

INTRODUCTION

The rapid development of information technology today, followed by the development of social media, has an essential role in the manufacturing sector [1]. The increasingly diverse customer demands make the industry must be able to adapt to these changes [2]. Everything has changed a lot, such as increasing global market competition, diverse customer demands, demand for product personalization, and much more [1, 3, 4]. Nowadays, the manufacturing industry is required to meet customer needs that are very diverse and can change at any time and follow specific trends [5]. In addition, to meet this trend, the manufacturing industry must also have various capabilities and flexibility in its production process, especially for customers who want product personalization [6]. However, it requires a lot of investment, for example, buying a new machine every time demand changes is not profitable from the manufacturer's development strategy [7]. Several companies implement a social manufacturing system to reduce production costs due to diverse and changing customer demands [8, 9].

Based on various product types and production quantities, the production model of manufacturing companies has undergone significant changes [10]. It is from handmade production, mass production, mass customization to individual production to meet increased efficiency, especially since the first industrial revolution [11, 12]. In addition to the social relations and developmental factors mentioned above, these changes also depend on the innovation of production organizations, the development of manufacturing technology itself [13], and technological products such as automation, computer science, information technology, etc. [14, 15, 16].

Internet-based communication in business has advanced along with the development of the internet, Internet of Things (IoT), and Cyber-Physical System (CPS) technology, creating organizational structures, business interactions in manufacturing companies and between different companies, facing enormous challenges [17, 18]. Manufacturing companies must answer these considerable challenges, for example, by changing their product manufacturing activities during the product life cycle and how they did it [19].

The purpose of the establishment of social manufacturing is to process information systematically, manage resources, provide services flexibly and on time to meet rapidly changing customer demands [20, 21]. It makes manufacturing evolve into intelligent manufacturing capable of meeting the changing demands of mass product customization [22, 23]. Therefore, social manufacturing is designed to connect social needs and resources in an active, fast and organized manner. The new paradigm of social manufacturing will become dominant with product personalization [24].

Various studies on social manufacturing have been carried out to explore various insights on social manufacturing in different domains (Table 1). In Table 1, it is shown that most of the articles discussing social manufacturing have been published in the last seven years. The majority of this review article focuses on selecting various strategies and technologies used to develop social manufacturing systems. It was also identified that most of the studies focused on a particular aspect or problem, such as mathematical modeling, simulation modeling, sustainability indicators, product development techniques, operations research, etc. This systematic literature review is structured to increase understanding of social manufacturing from a different perspective. Descriptive analysis is needed to explore various insights and general characteristics of social manufacturing. This article explores the literature's insights and opportunities by categorizing and analyzing selected articles from January 2017 to September 2021. The selected papers have been organized by year, publisher, journal, country of author, university affiliation, manufacturing industry, research design, and methods used. Based on these studies, this study discusses the development of trends in the social manufacturing system to provide an overview of the production processes in the social manufacturing system.

Table 1
Existing studies of social manufacturing

Author	Title	Source	Methodology	Results
Ding et al., 2015 [25]	Modeling and analyzing of an enterprise relationship network in the context of social manufacturing	Journal of Engineering Manufacture	Propose Model of Social Manufacturing Enterprise Relationship Network (SMERN)	The results show that SMERN is more significant, clustering algorithm is effective and SMEs are organized for collaboration with the manufacturing community
Zhou et al., 2016 [26]	Social Manufacturing xx Realizing Personalization Production: A state-of-the-art Review	IEEE Explore	Literature review on social manufacturing	The results of a review paper on the basic concepts and frameworks in social manufacturing
Jiang et al., 2016 [27]	Towards a cyber-physical-social-connected and service-oriented manufacturing paradigm: Social Manufacturing	Manufacturing Letters	Comparative analysis of social manufacturing and other manufacturing paradigms	CPSS platform in social manufacturing connects production service providers, and prosumers, through cyber, physical and social to collect data, which is useful for dynamic decision making, market prediction and product innovation
Hamalainen et al., 2017 [28]	Social manufacturing: When the maker movement meets interfirm production networks	Business Horizon	Conceptually defining two distinct forms of the firm-individual collaboration in manufacturing industries and empirically investigate the nature of firm-individual collaboration	Contribute to increasing understanding of how companies can build business models in the manufacturing industry by leveraging individual networks
Jiang and Leng, 2017 [29]	The configuration of social manufacturing: a social intelligence way toward service-oriented manufacturing	International Journal of Manufacturing Research	Provide knowledge in outsourcing and crowdsourcing concepts on social manufacturing for the entire lifecycle of mass personalization processes	A novel approach for enabling individualized mass production

Table 1 Continued
Existing studies of social manufacturing

Author	Title	Source	Methodology	Results
Guo and Jiang, 2018 [30]	An investigation on establishing small- and medium-sized enterprises communities under the environment of social manufacturing	Concurrent Engineering: Research and Applications	Propose a Socialized manufacturing resources (SMR) clustering and order allocation in SMEs community	Growing hierarchical self-organizing map (GHSOM) and the modified multi-objective bird swarm algorithm (MOBSA)
Xiong et al., 2018 [31]	From Mind to Products: Towards Social Manufacturing and Service	IEEE/CAA Journal of Automatica Sinica	Comparing mass customization and social manufacturing, then developing social manufacturing prototypes involving 3D printing, internet of things, cloud computing and intelligent systems	Development of three transformation models involving social manufacturing and 3D printing in different case studies
Shang et al., 2018 [32]	Social Manufacturing for High-end Apparel Customization	IEEE/CAA Journal of Automatica Sinica	Developing high-end apparel customization using cloud computing technology and crowdsourcing	Developing a social manufacturing model in the apparel industry by improving innovation, design, manufacture, marketing and service, to be more competitive in the future
Ding et al., 2018 [33]	RFID-enabled social manufacturing system for inter-enterprise monitoring and dispatching of integrated production and transportation tasks	Robotics and Computer–Integrated Manufacturing	Propose a radio frequency identification enabled social manufacturing system (RFID-SMS) to realize real-time monitoring and delivery of production and transportation inter-enterprise	Development of social manufacturing prototypes and case studies applied to printing machine companies, and the proposed model is evaluated by industry practitioners
Hirscher et al., 2018 [34]	Social manufacturing in the fashion sector: new value creation through alternative design strategies?	Journal of Cleaner Production	Developing a social manufacturing model for the fashion industry, using the do-it-yourself (DIY) and do-it-together (DIT) methods	A social manufacturing framework that has been demonstrated and uses data from Finland and the US
Xiao et al., 2019 [35]	Evaluating of dynamic service matching strategy for social-manufacturing in the cloud environment	Future Generation Computer Systems	Computational experiment-based evaluation framework, which can simulate all kinds of actual scenarios to verify the performance of strategy service matching, and has carried out case studies	Adaptive service supply-demand matching to maintain sustainable development in social manufacturing
Guo and Jiang, 2019 [36]	Product Service Systems for Social Manufacturing: A new service system with multi-provider	IFAC Papers OnLine	Implementing architecture and operational logic of Product-Service System (PSS) for social manufacturing	PSS for social manufacturing can help SMEs to improve and develop the transition to product services. Two case studies also confirm the effectiveness and feasibility of PSS for social manufacturing models
Song et al., 2019 [37]	Exploring robustness management of social internet of things for customization manufacturing	Future Generation Computer Systems	Manage the social reliability of the Internet of Things (SIoT) in a customization manufacturing (CM) environment from a complex systems perspective	Low interoperability and mismatch over high mismatch, and tight integration improves SIoT resilience under CM paradigm
Qian et al., 2020 [38]	Exploring the socialized operations of manufacturing resources for service flexibility and autonomy	Robotics and Computer Integrated Manufacturing	Develop a framework for socialized manufacturing resources, resourcing and service modeling virtually using finite state machines	The initial design of the social network was resource oriented and provided solutions that allowed for the development of autonomy and flexibility of manufacturing systems.

The studies on social manufacturing that have been described in Table 1 are the latest references in the last five years. From these studies, it can be further developed into other, more comprehensive research, with a variety of different methods.

LITERATURE REVIEW

The literature review was conducted to understand the definitions and terms in social manufacturing and integrated production systems. Research related to social manufacturing has been carried out as summarized in Table 2. The research is classified based on customer needs [4], approach used to customers [32, 34, 39], customization mode [26], production mode [31], customer participation [40], technology used [33, 35, 37, 41], advantage of social manufacturing [25, 27].

Table 2
Research of social manufacturing

Item	Description	Reference
Customer needs	Meeting personalization and individual needs at the same time	[4]
Approach to customers	Customer requests individually according to product personalized design	[32, 34, 39]
Production mode	Personalized product design and manufacture, with a higher degree of flexibility	[31]
Customization mode	One product personalization for one customization	[26]
Technology used	IoT, social network, 3D printing, cloud computing, Knowledge-based Intelligent Systems, and social manufacturing based on the cloud platform	[33, 35, 37, 41]
Customer participation	Interactive design and manufacture of personalized products, customization with any content and a higher level of accuracy	[40]
Advantage of social manufacturing	Highest added value at affordable cost	[25, 27]

Different industrial entrepreneurs in the manufacturing network are increasingly getting great opportunities along with the development of internet technology [42]. For example, People can use in-house manufacturing tools for decentralized production processes [11]. Through this type of crowdsourcing, enterprises can respond to request for personalized products [43]. This new type of producer-customer relationship allows the formation of a manufacturing model that can be referred to as "Social Manufacturing" [26]. This new method can reduce the cost of labor, financing, and other manufacturing capital expenditures, and will also improve market responsiveness [44, 45, 46]. Therefore, the advantages of using the social manufacturing model allow the manufacturing industry to save on production costs [25]. In addition, Professor Wang explores new social aspects of manufacturing in his article "From social computation to social manufacturing" [47].

The social model of manufacturing was proposed in 2012 and later researched by several experts [26, 27, 28, 41, 48]. Compared to traditional manufacturing modes, the features of social manufacturing are better, indicated by customer requests that can be reflected directly into a product, otherwise known as "From mind to product" [31], where every customer can participate in the whole process of product design, manufacture and even marketing [14]. Customer participation becomes a behaviour, which allows them to get more profit and satisfaction from the desired product [49]. User experience can be improved through personalization, the potential demand for released products, and increased production customization efficiency [50, 51, 52]. On the other hand, in the view of socialized producers, social manufacturing is a variety of stakeholders who have Socialized Manufacturing Resources (SMR), including micro, small, medium-sized industries (MSMEs), smart factories, workshops, logistics service providers, and public warehouse providers, who form social media-based communities with producers to collaborate on crowdsourcing or outsourcing tasks [53, 54, 55, 56]. Through the development of the internet and social networks, communication and exchange of information between SMRs has become easier [13, 57].

METHODS

The method used in writing this systematic literature review is to search for papers related to social manufacturing sourced from a reputable journal database, namely Scopus. The first step is to enter the keyword "social manufacturing", and the year limit for the document to be processed. The second step is to select what information is needed, then download the metadata file from Scopus in the form of .csv and .isk extensions. After the metadata file is downloaded from the Scopus page, the third step is processed using the VOSviewer software version 1.6.17 for 2021 to map the Author and Co-Author networks and terms that usually appear in social manufacturing papers. VOSviewer is very popular and has the following characteristics:

- different mapping types of bibliometric analysis;
- supports several major bibliographic databases;
- the time dimension is ignored;
- limited to analyzing small to medium amounts of data;
- intended for the function of processing text;
- using layout and cluster techniques;
- use advanced visualization features;
- using a visual labelling system;
- using overlay and density visualization.

Types of bibliometric mapping that VOSviewer is capable of:

a) Co-authorship maps, consisting of authors, organizations, countries;
b) Citation maps, consisting of publications, journals, organizations, countries;
c) Co-citation maps, consisting of publications, journals, authors (first author only);
d) Bibliographic coupling maps, consisting of publications, journals, authors, organizations and countries;
e) Subject/keyword mapping (Co-occurrence maps), consisting of keywords and terms from the title and abstract.

In addition, the review paper is also carried out by entering the keywords "social manufacturing" and "production system" in the Scopus database. Next, download the data obtained and process it to map information on Publication Year, Document Type, and Publisher.

RESULTS AND DISCUSSION

Compiling a literature review begins with collecting data from a reputable international journal database, namely Scopus. The keyword entered to obtain information is "social manufacturing" and is limited to 2017 to 2021. The results obtained are that there are 2163 papers on social manufacturing. The first processing is data about what terms often appear in social manufacturing papers, which are developed using the VOSviewer version 1.6.17 for 2021 software. As a result, 5616 terms were found on social manufacturing, then 71 papers that met the threshold were found, and the most match is about 60% or about 43 items. Furthermore, the 43 items were divided into 5 clusters, with the distribution as presented in Table 3, with 249 links and 523 total link strength, as presented in Fig. 1.

Table 3
Cluster distribution of terms in social manufacturing

Cluster	Number of Items	Items
1	11	application, blockchain, context, decision, framework, human-robot collaboration, industrial robot, influence investigation, social manufacturing, sustainable manufacturing
2	11	corporate social responsibility, csr, evidence, financial performance, firm, manufacturing firm, moderating role, performance, relationship, role, social sustainability
3	8	additive manufacturing, approach, design, energy, optimization, process, system, trade
4	7	challenge, covid, implementation, India, opportunity, review, worker
5	6	circular economy, cloud, implication, internet, knowledge, thing

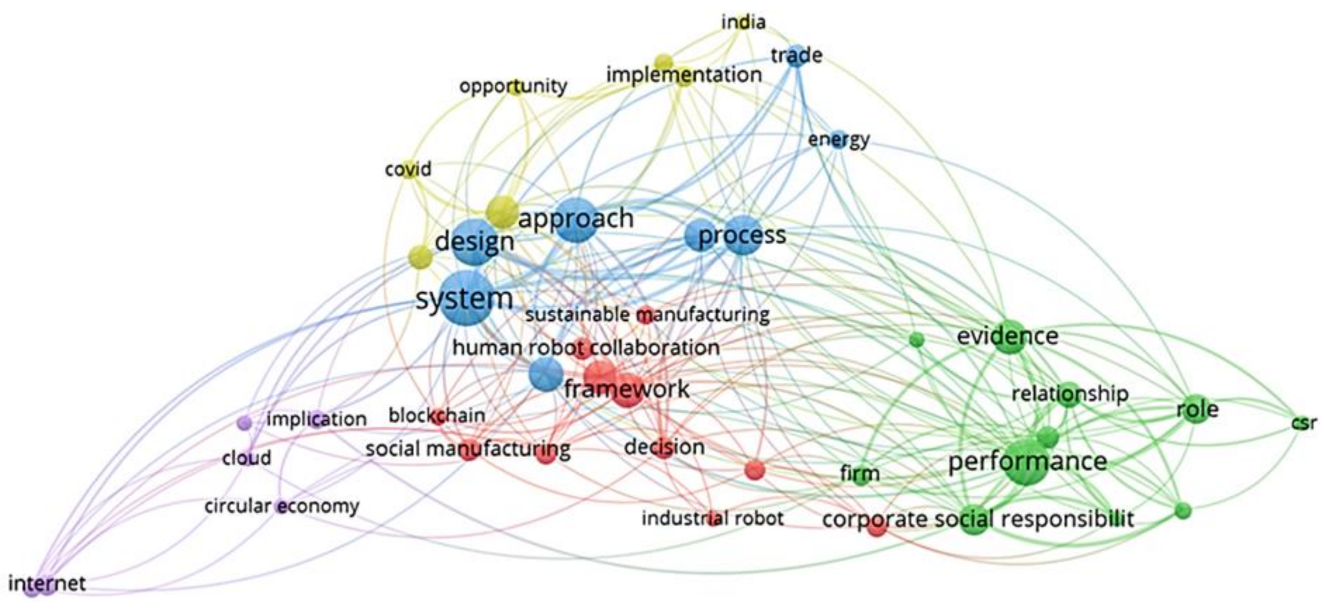

Fig. 1 Network distribution link of the terms of paper

Then, an analysis was carried out using the No Normalization method from 43 items of terms that often appear in social manufacturing, as presented in Fig. 2. The terms that most often appear in social manufacturing papers include system, design, performance, framework, process and collaboration. The larger the round sign of the mapping result, it indicates that the term is often used in social manufacturing papers.

The next process is mapping the Author and Co-Author using VOSviewer. From the search results, data were obtained from 5675 authors who write about social manufacturing. Then, from the 5675 number, screening was carried out to find author data with a minimum number of 5 paper titles. The screening results show 101 authors and co-authors from 5675 authors who have at least five social manufacturing papers. From these data, 93 authors match a minimum of 5 papers and a maximum of 25 papers, with the keyword "social manufacturing".

These 93 authors are divided into 9 clusters based on the collaboration of writing and authorship. Cluster 1 (17 items), cluster 2 (16 items), cluster 3 (13 items), cluster 4 (11 items), cluster 5 (10 items), cluster 6 (9 items), cluster 7 (9 items), cluster 8 (4 items), cluster 9 (4 items), as presented in Fig. 3.

In addition to the data mentioned above, this review also searched the Scopus page with the keywords "social manufacturing" and "production system", from 2017 to 2021. The search results showed there were 167 papers with these two keywords. These 167 papers were analyzed, starting from the year of publication, the type of document, and the publisher's name.

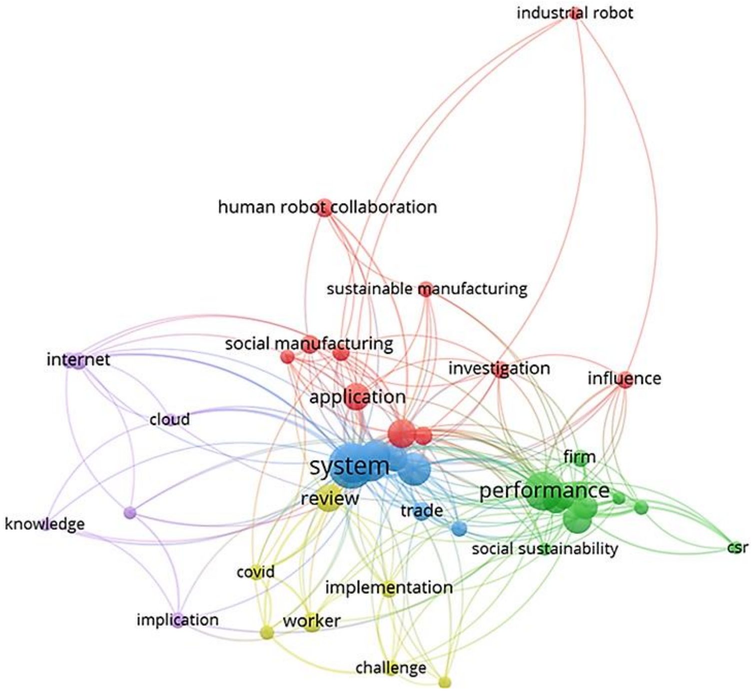

Fig. 2 No Normalization analysis from VOSviewer

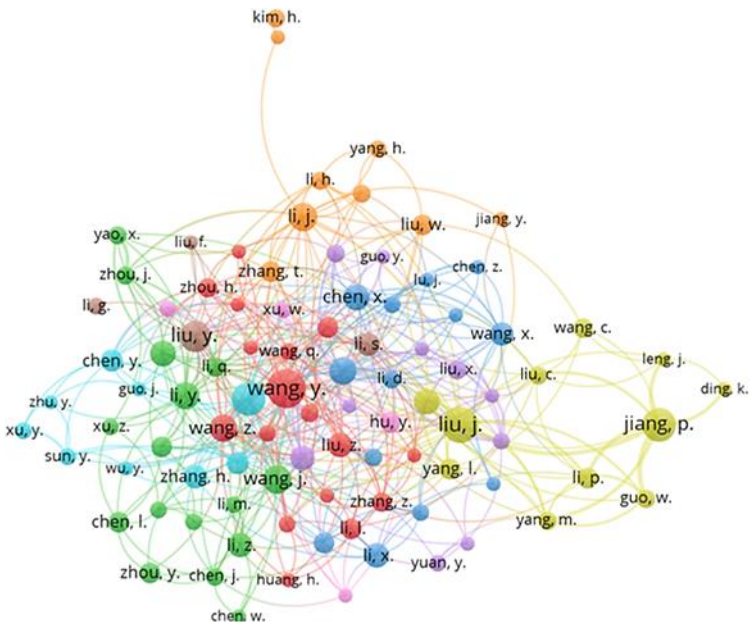

Fig. 3 Mapping of author and co-author

The analysis results for the Year of Publication are presented in Fig. 4, namely the publication data from 2017 to 2021. In the graph of Fig. 4. It can be seen that the publications on social manufacturing in 2021 are 40 paper titles (23.9%), in 2020, there are 43 paper titles (25.7%), in 2019, there are 29 paper titles (17.4%), in 2018, there are 27 paper titles (16.2%), and in 2017 there were 28 paper titles (16.8%).

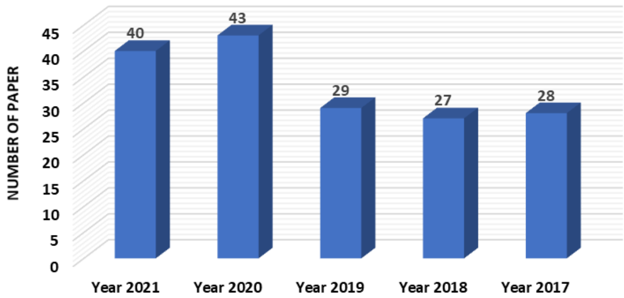

Fig. 4 Year of publication

Then for the Document Type, it is divided into four types, namely articles, book chapters, conference papers, and review papers. In Fig. 5, you can see the number of papers of Article type (90 titles), Book Chapters (3 titles), Conference Papers (68 titles), and Review Papers (6 titles).

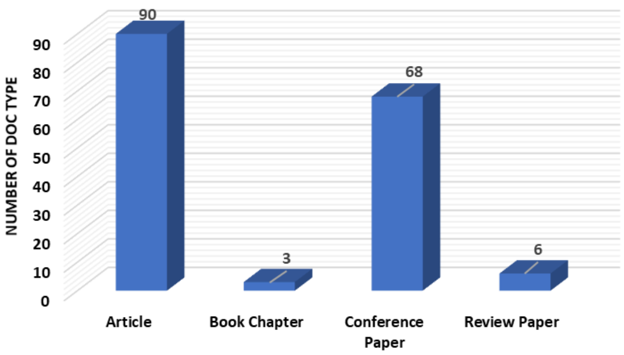

Fig. 5 Document type

The distribution of papers by the publisher is presented in Fig. 6, with a minimum number of 5 papers, including Elsevier B.V., IEEE, IOP, Springer, MDPI, SAGE, Taylor and Francis Ltd., and others. The total number of papers divided into these publishers is 167.

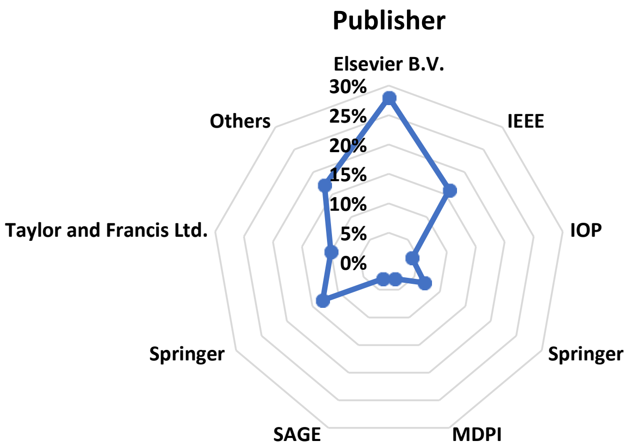

Fig. 6 Journal publisher

There are 13 other publishers in the 'Others' category in the picture, eight publishers with one each, two publishers with two each, and three publishers with three titles each. Social manufacturing papers are widely published by reputable publishers such as Elsevier, IEEE, IOP, Springer, MDPI, SAGE, and also Taylor and Francis Ltd.

CONCLUSION

This systematic literature review aims to discuss the development of research in the field of social manufacturing. The method used to search the data is to download files from a reputable international journal database, Scopus, with the keywords social manufacturing and production system. One of the contributions to this research is the mapping and categorization of papers based on auto, co-author, definition of social manufacturing, terms that often appear in social manufacturing papers, year of publication, document type, and publisher. This contribution can be seen from the results of data mapping using VOSviewer software to classify author, co-author and terms data in social manufacturing. This research still has shortcomings, so it can be improved in future research. Research opportunities that can be carried out are by conducting a more in-depth systematic literature review, such as the author's country of origin, affiliation data, and others. In addition, for further research, other application software can be used for mapping research papers. This systematic literature review can be one of the references for basic research on social manufacturing.

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Bentuk Dukungan/ Total Kontribusi Dana	:	Rp 10.000.000, 00 (Sepuluh juta rupiah) / tahun

Dan saya menyatakan bahwa saya tidak memiliki afiliasi atau hubungan keluarga dengan tim pengusul. Demikian pernyataan ini saya buat dengan sebenar-benarnya untuk digunakan sebagaimana mestinya.

Sleman, 14 Maret 2025
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Disetujui LPPM :

Komponen Administrasi	Kesesuaian
Kesesuaian Isi Per Bagian	Sesuai
Jumlah Kata Per Bagian	Sesuai
Model Penulisan Sitasi dan Penulisan Daftar Pustaka	Sesuai
Ketua Pengusul Memiliki Hasil Penelitian Yang Relevan Dalam Bentuk Artikel Di Jurnal Sebagai Penulis Pertama (First author) atau Penulis Korespondensi (Corresponding Author)	Sesuai
Memiliki Mitra Yang Dibuktikan Dengan Surat Pernyataan	Sesuai

Komentar: Proposal lengkap dan sudah memenuhi ketentuan skema penelitian terapan