Sustainable manufacturer engineering for Industry 6.0

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Abstract. This is axiomatic design (AD) research of Finnish Manufacturers practices to optimize design principles in European-level. We dive into the deep end of the pool by leveraging cutting-edge AD methodology by partnering with businesses surveying to see best productivity. The companies are integrated from simplified industry 6.0 perspective, while some industries technology readiness is benchmarked between 4.0-5.0 compliant. In this paper we take new insights into consideration from the supply chain, understanding contracts, competitiveness, and profit-seeking companies' sustainability strategies. We discover high-order axioms and their complex, multidimensional modeling, refined through supplier selection models. Hold tight as we focus on organizational planning based on sustainable process management. Observe how outsourcing simplifies organizational structures and how the complex becomes simple when the production organization aligns to maximize revenue, control, and management. Witness the creation of a decoupled AD for higher-level manufacturing organizations design suitable for horizon financing activities.

Keywords: axiomatic design, organizational concepts, European manufacturing survey

1 Introduction

AD principles have gained traction, with researchers exploring new applications beyond traditional engineering design, including manufacturing engineering [1]. Emphasizing manufacturing engineering leads to successful operations through effective organizational design, which can transform supply chains and create ripples in society. Crucial to any manufacturing capacity, successful operations necessitate efficient manufacturing organizations [2]. To address uncertainties, semi-structured surveying methods have been combined with Axiomatic Design (AD) [3].

Historically, organizational practices focused on manual labor for added-value jobs divided into specialized tasks. However, recent decades have seen industrial engineers shift their focus towards systematic thinking in human-centered design (HCD) to improve productivity [4, 18]. This approach addresses the integration of various human systems in response to technological challenges in industrial markets. In this study, AD been employed in research and development methodologies within small and medium-sized enterprises (SMEs) to create flexible and agile manufacturing system integration. While other design principles share similarities with AD, many is less relevant in effective generation of design domains [5]. Consequently, AD will be used in this study to examine new organizational design.

A four-layer representation of the production system consists of enterprise organization, plant organization, production organization, and operation. The system depends on resources or technologies within the production layout, with innovation contributing to the enterprise's value from an operational standpoint. The entire organizational scope, from goal-setting to strategy development and process execution, defines the enterprise's value. Production encompasses various stakeholders, including customers and businesses (e.g., distributors). Improving organizational design in production can be divided into three managerial tasks: problem-solving in design and engineering, information management, and resource transformation [6].

This research investigates the applicability of two fundamental axioms in organizational design. Axiomatic domain mapping for the production system design levels is achieved using empirical findings from the business portfolio. Axiom 1 maintains the independence of functional requirements (FRs), while Axiom 2 minimizes the design's information content. These axioms form the basis of design domain relationships, addressing the complexity of interconnections between customer domains, constrained FRs, and design parameters [6, 11-13].

Axiomatic vector spaces provide the foundation for finite-dimensional prototype matrices [1]. Real number scalars denote a collection of vectors within these matrices, allowing linear algebra to effectively represent relationships between various entities [2]. In this study, we utilize empirical data obtained from Finnish manufacturing companies participating in the European Manufacturing Survey (EMS) [3]. By characterizing the primary production of these enterprises through ideal organizational practices associated with growth companies, we derive insights from the connections and magnitudes of the measured observations [4].

2 Empirical method and material

This study utilizes manufacturing research measurements from the Finnish manufacturing industry. The Delphi approach, along with axiomatic theories, has been suggested in previous research as a suitable method for data analysis (e.g., [7]).

2.1 EMS Data Source

Data were collected from Finnish manufacturing companies using the EMS research instrument. Company representatives responded to coded arguments (abbreviated as coding) [8]. Z-score normalization was applied to the data using IBM's statistical package for social science analysis. The sample comprised of supply chain contract (SCC) companies, including operating manufacturers (MFR, m03a1-m03a3), contracted suppliers (SPLR, m03a4-m03a5), and contract manufacturers (CM, m03a6) [8].

The study investigates the development of competitiveness and employment situations from the perspectives of turnover, employees' salaries, and capital utilization in SCC companies [8]. Selected variables include annual turnover (AT, m23a1), number of employees (NEs, m23b1), manufacturing capacity utilization (MCU, m23h), and return-on-sales (ROS, m23i1-m23i5) [8].

Organization concepts (OCs) consist of surpassing Industry 4.0 readiness to emphasized human creativity and innovativeness to Industry 5.0, while partially we use the sample from integration of industry 6.0 perspective:

a. Organizing production (OP), which involves planning (OP1, m06a1), customer- or product-oriented lines/cells organization (OP2, m06b1), the pull principle (OP3, m06c1), change-over time optimization or set-up time reduction (OP4, m06d1), and standardized work instructions organization (OP5, m06e1) for Industry 4.0-5.0.
b. Production management and control (PMC), which includes visual management (PMC1, m06f1), quality standard-based manufacturing (PMC2, m06g1), employee involvement in manufacturing and innovation (PMC3, m06h1), bonus systems for outstanding performances (PMC4, m06i1), environmentally conscious manufacturing (PMC5, m06k1), and energy management (PMC6, m06l1) for Industry 4.0-5.0.
c. Task- (TCD1, m17a1), cross-functional- (TCD2, m17b1), digital product/system implementation support- (TCD3, m17c1), and data security/compliance-related (TCD4, m17d1) TCD key measures [8] for industry 5.0.

SPSS was used to process the observed variables, yielding an outcome space for each organization (n=31). Table 1 presents the descriptive matrix, while table 2 displays the correlations.

Table 1. The descriptive matrix according to the observed variables for the production organizations [8].

	MIN	MAX	M	MED	MOD	STD	SKEW	KURT	SUM	VALID
AT21	0,40	220,00	39,32	7,85	6,00	58,03	1,97	3,96	786,48	20,00
AT19	0,10	250,00	36,37	7,00	6,00	63,20	2,54	6,99	691,08	19,00
NE21	4,00	600,00	129,86	70,00	4[a]	157,61	1,99	3,69	2857,00	22,00
NE19	3,00	500,00	113,55	50,00	50,00	138,70	1,82	2,65	2498,00	22,00
MCU21	0,00	100,00	68,00	80,00	80,00	30,99	-1,32	0,82	1224,00	18,00
MCU19	0,00	100,00	65,00	79,00	80,00	32,82	-0,93	-0,47	975,00	15,00
ROS	1,00	5,00	3,79	5,00	5,00	1,62	-1,03	-0,58	72,00	19,00
OCs	0,09	1,00	0,53	0,55	0,55	0,26	0,19	-0,57	16,45	31,00
OP	0,00	1,00	0,50	0,40	0,40	0,30	0,24	-0,68	15,40	31,00
PMC	0,00	1,00	0,56	0,67	0,17	0,31	-0,23	-1,28	17,33	31,00
TCD	0,00	1,00	0,63	0,60	.4[a]	0,29	-0,45	-0,40	19,00	30,00
OP1	0,00	1,00	0,55	1,00	1,00	0,51	-0,20	-2,10	17,00	31,00
OP2	0,00	1,00	0,48	0,00	0,00	0,51	0,07	-2,14	15,00	31,00
OP3	0,00	1,00	0,52	1,00	1,00	0,51	-0,07	-2,14	16,00	31,00
OP4	0,00	1,00	0,32	0,00	0,00	0,48	0,80	-1,46	10,00	31,00
OP5	0,00	1,00	0,61	1,00	1,00	0,50	-0,49	-1,89	19,00	31,00
PMC1	0,00	1,00	0,45	0,00	0,00	0,51	0,20	-2,10	14,00	31,00
PMC2	0,00	1,00	0,58	1,00	1,00	0,50	-0,34	-2,02	18,00	31,00
PMC3	0,00	1,00	0,71	1,00	1,00	0,46	-0,97	-1,13	22,00	31,00
PMC4	0,00	1,00	0,87	1,00	1,00	0,34	-2,33	3,65	27,00	31,00
PMC5	0,00	1,00	0,55	1,00	1,00	0,51	-0,20	-2,10	17,00	31,00
PMC6	0,00	1,00	0,19	0,00	0,00	0,40	1,63	0,70	6,00	31,00
TCD1	0,40	220,00	39,32	7,85	6,00	58,03	1,97	3,96	786,48	20,00
TCD2	0,10	250,00	36,37	7,00	6,00	63,20	2,54	6,99	691,08	19,00
TCD3	4,00	600,00	129,86	70,00	4[a]	157,61	1,99	3,69	2857,00	22,00
TCD4	3,00	500,00	113,55	50,00	50,00	138,70	1,82	2,65	2498,00	22,00

Table 2. The correlation matrix according to the observed variables for the production organizations [8].

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
AT21	1																										
AT19	.991****	1																									
NE21	.818****	.807****	1																								
NE19	.822****	.831****	.983****	1																							
MCU21	.243*	.267**	.131	.123	1																						
MCU19	.245*	.244*	.209	.195	.829***	1																					
ROS	.233**	.221*	.221*	.203*	.300**	.241*	1																				
OCs	.179	.177	.364****	.360****	.173	.157	.341***	1																			
OP	.094	.090	.235**	.226**	.114	.145	.225**	.853****	1																		
PMC	.222*	.224*	.405****	.409****	.182	.116	.376****	.851****	.451****	1																	
TCD	.062	.041	.245**	.215*	.144	.149	.166	.418****	.369****	.343****	1																
OP1	.052	.043	.117	.110	.091	.082	.179	.602****	.692****	.333****	.119	1															
OP2	.023	.011	.129	.107	.021	.022	.202*	.602****	.751****	.273***	.345****	.455****	1														
OP3	.024	.032	.128	.122	.024	.086	.103	.509****	.669****	.196**	.165*	.298****	.467****	1													
OP4	.172	.168	.317***	.321***	-.030	.053	.086	.565****	.670****	.291***	.227***	.364****	.322****	.266***	1												
OP5	.068	.071	.147	.149	.280***	.252*	.219*	.633****	.630****	.448****	.402****	.245***	.303****	.240***	.361****	1											
PMC1	-.030	-.041	.107	.070	.066	.023	.310***	.544****	.304****	.625****	.235**	.289****	.154*	.205**	.149*	.237***	1										
PMC2	.002	-.002	.184*	.193*	.160	.195	.320****	.527****	.269***	.631****	.173*	.270***	.131	.078	.150*	.288***	.301****	1									
PMC3	.022	.023	.117	.090	.051	.012	.100	.498****	.278***	.571****	.294***	.164*	.264***	.254***	.024	.233**	.264***	.255***	1								
PMC4	.262**	.262**	.290***	.294***	-.019	.045	.209*	.602****	.333****	.694****	.196**	.220**	.212**	.165*	.218**	.321****	.280***	.335****	.364****	1							
PMC5	.224**	.225**	.344***	.376***	.210*	.053	.284**	.548****	.284***	.650****	.202**	.196**	.090	-.027	.345****	.374****	.220**	.371****	.069	.325****	1						
PMC6	.363***	.388****	.475****	.518****	.206	.110	.103	.401****	.177*	.507****	.131	.072	.154*	.023	.175*	.184**	.154*	.141	.111	.213**	.393****	1					
TCD1	-.024	-.050	.068	.039	.301**	.259**	.116	.237***	.251***	.152*	.653****	.059	.218**	.106	.231**	.246***	.098	.066	-.012	.092	.197**	.110	1				
TCD2	.093	.079	.230**	.220**	-.054	-.035	.041	.355****	.253***	.352****	.702****	.054	.283***	.065	.083	.373****	.133	.121	.392****	.163*	.216**	.270***	.280***	1			
TCD3	.132	.103	.252**	.221**	.159	.266**	.045	.262***	.258***	.187**	.683****	.154*	.171*	.127	.206**	.227**	.185**	.196**	.134	.075	.095	-.025	.329****	.356****	1		
TCD4	.007	-.002	.144	.130	.016	-.028	.137	.326****	.351****	.203**	.794****	.132	.340****	.144	.217**	.365****	.088	.141	.165*	.114	.143	.088	.393****	.463****	.469****	1	
TCD5	.010	.010	.151	.127	.069	.048	.237**	.288***	.187**	.305****	.687****	.021	.201**	.140	.071	.202**	.317****	.082	.334****	.242***	.064	.017	.336****	.350****	.252***	.465****	1

2.2 Extracting statistics into axiom testing

The integration in systems engineering is examined through cross-tabulation, a method of data analysis that scrutinizes the relationships between variables with the aid of convenience sampling. This approach yields numerical values that reflect relationships with syntactical and semantical significance, thus facilitating supervised learning in pairs, and offering insights into the data reliability among factors.

From a systems design perspective, challenges are identified, milestones towards goals are set, and concepts evaluated, eventually leading to the selection of an optimal function as a system function. The axiomatic perspective allows for the evaluation of the design quality. Systems designed to address challenges underscore the importance of hierarchy in the design of subsystems, with the creation and evaluation of processes based on manufacturability or maintenance. Successful strategies are managed then with AD.

2.3 Advanced engineering and technology solutions

AD, particularly the sequential zig-zag approach, elucidates compact system structures with an emphasis on the design life cycle [9]. Complex systems should maximize functional independence and minimize information content. Ideally, an uncoupled model is preferred over a coupled model [10]. Stability in the long term can be achieved by a simplified system version [9 adapted to 10].

In the context of organizational design, multi-level components originating from EMS research precede the empirical evidence of each variable, enabling axiom testing. The tangible and intangible elements contributing to an organization's operations are emphasized on the practical side, while the empirical side relies on collected samples. Given the range of policies and integration domains, it's an opportunity to examine sociotechnical systems, amalgamate their organizational structures and practices, and select processes from unique systems for conversion to individual cultures, based on integration optimization.

A sample of respondents from the manufacturing sector provided products as a linear combination represented by $(2\mathrm{a} + 10\mathrm{b} + 5\mathrm{c} + 4\mathrm{d} + 2\mathrm{e} + 2\mathrm{f} + 2\mathrm{g} + 2\mathrm{h} + 3\mathrm{i} = 0)$, and further interconnectedness of various technologies $[f(2\mathrm{a}, 10\mathrm{b}, 5\mathrm{c}, 4\mathrm{d}, 2\mathrm{e}, 2\mathrm{f}, 2\mathrm{g}, 2\mathrm{h}, 3\mathrm{i}) = 0]$, Manufacturers' generalized views encompass other services. While the main product is recognizable to another sector, it must still relate to the precise manufacturing and operational needs with design parameter (DP) representing the design layout. These various designs were based on the design for renewable energy solutions (a, DP1); metal fabrication and construction (b, DP2); electronics and communication systems (c, DP3); element products (d, DP4); electromechanical systems (e, DP5); controlled environment solutions (f, DP6); ship engineering (g, DP7); software development and integration (h, DP8); machinery and hydraulic systems (i, DP9) [8]. The domains require mapping on unit vectors to reflect the systems' integrationist perspective from advanced engineering and technologies. By organizing the concepts in this manner, it becomes easier to understand the relationships between them and how advancements in one domain might influence or be influenced by those in another aligned with the design matrix (DM) and design parameters (DP) has to be aligned [11], represented in (1) as $\boldsymbol{FR} = [\boldsymbol{DM}] \times \boldsymbol{DP}$, where $\boldsymbol{DM_{ij}} = \frac{\partial \boldsymbol{FR_i}}{\partial \boldsymbol{DP_j}}$.

$$\{\boldsymbol{FR}\} = \begin{vmatrix} \boldsymbol{2a} & & & & & & & & \\ & \boldsymbol{10b} & & & & & & & \\ & & \boldsymbol{5c} & & & & & & \\ & & & \boldsymbol{4d} & & & & & \\ & & & & \boldsymbol{2e} & & & & \\ & & & & & \boldsymbol{2f} & & & \\ & & & & & & \boldsymbol{2g} & & \\ & & & & & & & \boldsymbol{2h} & \\ & & & & & & & & \boldsymbol{3i} \end{vmatrix} \times \begin{Bmatrix} \boldsymbol{DP1} \\ \boldsymbol{DP2} \\ \boldsymbol{DP3} \\ \boldsymbol{DP4} \\ \boldsymbol{DP5} \\ \boldsymbol{DP6} \\ \boldsymbol{DP7} \\ \boldsymbol{DP8} \\ \boldsymbol{DP9} \end{Bmatrix} \tag{1}$$

The need for mapping investigation from an intangible process domain is suggested by [11, 258]. The {FR} domain levels for concurrent engineering can be expressed as in [12].

The design for various sectors such as engineering offices, metal, electrical/electronic, construction, software, chemical, marine, machine, and supplier systems, can be established by mapping the {FR}, [DM] and {DP} character vectors.

The sample also represents customer domains of enterprises, which include engineering offices that consult and manage product manufacturing processes according to customer requirements. The metal industry deals with large-scale production using additive and subtractive manufacturing techniques to create end products. The electrical industry focuses on the production of new electronics and the complex installation from a construction viewpoint, extending the design from an engineering facilities perspective.

The intangible viewpoint aligns with the perspective of software producers, extending the design to chemical manufacturing, which produces industrial chemicals as resources. Recreational manufacturing, concerning the manufacture of ships, considers the differences between machinery design manufacturing and suppliers, which are crucial across all industries. This viewpoint, particularly relevant to general suppliers, enhances the distribution characteristics that respond to customer-specific solutions.

The performance of these companies concerning their organizational practices was chosen for testing to offer each company its axiomatic optimum, such as directing towards industry 6.0 systems integration, which may be yet fictious but as research initiative. A core model was selected from these companies based on the integrability of the products and the use of axiomatic theory was expanded to include the variants emerging from recent literature, indicating the research popularity of this area. A successful transition requires continuous knowledge exchange between and within different design domains, e.g., [12].

3 AD of a manufacturing organization

AD offers a solution for achieving design independence early in the program phase. This chapter discusses the formulation of assumptions based on hierarchical decomposition and determining if an organization requires specific practices or if it can be adaptable.

Prior conceptual design reflection chapter concluded the used enterprises and noted the functionality basis of the design of a system. Herein the design of the manufacturing systems is human centered. Generally, a manufacturing system comprises a series of processes surrounding the business owner, namely, design, materials, refining and assembly. Modeling the entire manufacturing structure supports organizational productivity and must be viewed because the components are connected. The AD introduced previously encouraged independence and information number representation. As per the following optimization, we are applying an axiomatic approach by advancing axioms to each component from the production side (adapted to [13]).

AD of a manufacturing organization can be summarized by applying an axiomatic approach to each component from the production side, based on the functionality basis of the system design. The manufacturing systems are human-centered and consist of processes like design, materials, refining, and assembly. The AD encourages independence and information number representation. The following equations represent the observed relationships as $\boldsymbol{F}(\boldsymbol{X},\ \boldsymbol{Y},\boldsymbol{Z}) = \boldsymbol{h}(\boldsymbol{x_1},\dots,\boldsymbol{x_n}),\boldsymbol{h}(\boldsymbol{y_1},\dots,\boldsymbol{y_n}),\boldsymbol{h}(\boldsymbol{z_1},\dots,\boldsymbol{z_n})$ in (1). In the Finnish manufacturing domain, the establishment of innovative thematics for organization concepts (OCs): organizing production (OP) design procedures, and production management/control (PMC) and training & competence development (TCD) that are represented as partial tensors from profitable utilization both sides, two parts representing labor market turnover (LMT, j), and dollar utilization (DU, k) as minimized (A's criterion) as continuing to (1).

$$A = F(\boldsymbol{X},\boldsymbol{Y},\boldsymbol{Z}) = \begin{vmatrix} \boldsymbol{h}(\boldsymbol{x_1},\dots,\boldsymbol{x_n}) \\ \boldsymbol{h}(\boldsymbol{y_1},\dots,\boldsymbol{y_n}) \\ \boldsymbol{h}(\boldsymbol{z_1},\dots,\boldsymbol{z_n}) \end{vmatrix} \begin{pmatrix} j \\ k \end{pmatrix} = \mathrm{OC}\begin{pmatrix} \mathrm{OP} \\ \mathrm{PMC} \\ \mathrm{TCD} \end{pmatrix}\begin{pmatrix} \mathrm{LMT} \\ \mathrm{DU} \end{pmatrix} = \mathrm{h\,f}\left(\mathrm{x,y,z}\begin{pmatrix} \mathrm{j} \\ \mathrm{k} \end{pmatrix}\right) \tag{1}$$

Where the data processor takes following parameters,

x_1= integration of tasks
x_2=Customer-/product-oriented lines/cells
x_3=Pull principle production control
x_4=Change-over time optimization
x_5=Standardized work instructions
y_1= Visual management & monitoring
y_2= Quality assurance methods
y_3= Employee innovation involvement
y_4= Employee performance bonus system
y_5= Certified environmental mgt. (ISO 14001/EMAS)
y_6= Certified energy mgt. (ISO 50001)
$\boldsymbol{z_1}$= Task-specific focus
$\boldsymbol{z_2}$= Cross-functional focus
$\boldsymbol{z_3}$= Digital production technology support
$\boldsymbol{z_4}$= Data security & compliance
$\boldsymbol{z_5}$= Creativity & innovation focus
$\boldsymbol{z_6}$= Project management
$\boldsymbol{j_1}$= annual turnover
$\boldsymbol{j_2}$= number of employees
$\boldsymbol{k_1}$= manufacturing capacity utilization
$\boldsymbol{k_2}$= profit

The final coupled matrix for the organization, based on a priori optimization, is shown in equation (2).

$$\boldsymbol{OCi = DPI} \tag{2}$$

Customer requirements $\{\boldsymbol{CR}\}$ correspond to the space chosen from the Finnish equivalents of European manufacturing research $\{\boldsymbol{FR_i}\}$. The aim is to respond to these from the axiomatic perspective of the $\{\boldsymbol{FR}\} = \{\boldsymbol{A}\}\{\boldsymbol{DP}\}$, when the simplified form of the matrix prototype becomes (3), which information criteria (IC) is minimized [14]:

$$\boldsymbol{FR} = \{\boldsymbol{A}\} \times \{\boldsymbol{DP}\} \text{ by minimized IC } \left(\mathbf{log}_{e}\frac{\mathbf{1}}{\mathbf{p}_{s}}\right) \tag{3}$$

While specifying system terms, practices and maintenance must be maintained to a corresponding firm related to the decoupling given in (4).

$$\begin{Bmatrix} FR1 \\ FR2 \\ FR3 \\ FR4 \\ FR5 \\ FR6 \\ FR7 \\ FR8 \\ FR9 \\ FR10 \\ FR11 \\ FR12 \\ FR13 \\ FR14 \\ FR15 \\ FR16 \\ FR17 \end{Bmatrix} = \begin{vmatrix} X&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&X&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&X&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&X&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&X&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&X&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&X&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&X&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&X&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&X&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&X&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&X&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&X&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&X&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&X&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&X&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&X \end{vmatrix} \times \begin{Bmatrix} DP1 \\ DP2 \\ DP3 \\ DP4 \\ DP5 \\ DP6 \\ DP7 \\ DP8 \\ DP9 \\ DP10 \\ DP11 \\ DP12 \\ DP13 \\ DP14 \\ DP15 \\ DP16 \\ DP17 \end{Bmatrix} \tag{4}$$

Enterprise parameters from the process domain justify the results of the process, as new growth companies are dependent on the latest technology to create new products. In terms of production and service maintenance, the popular processes tend to suit the customers' requirements, which is convenient for research and development, increasing employment numbers in organizations with a desire for growth and orienting them toward an incremental innovation perspective. Success can be seen in the investment targets of large companies, which reserve competitiveness for the market, as new types of systems are required. The simplicity of the manufacturing organization can lead to slightly more complex (applied [15]) systems. A design practice that achieves the goal of AD can be found in indices [16]:

Building an organization to resolve challenges while supporting sustainable development is not the task of one company. The company's best strategy depends on the customers' requirements for innovation. Innovations are based on capital flow, increasing sales and controlling labor costs, (for example, [7, 6]). Strategically, product design and manufacturing can be decentralized among stakeholders and can influence the development of new corporations in terms of coupled design.

3.1 Optimizing total sustainability

As a result, organizations can achieve greater efficiency and effectiveness in their sustainability endeavors by considering few aspects. Quality control measures, for example, help preventing unwanted working culture from product contamination while promoting process innovation to maximize quality [7]. A human resource vision that fosters a culture of competence and adaptability supports system and operational control, ultimately enhancing product delivery to market [17]. This approach to human resource management, emphasizing competence training, cultivates new cultural advantages and contributes to the effective management of products reaching the market [17]. The resulting solution is a decoupled sustainability approach optimized for an organization's economic design enhances workforce performance, contributing to the long-term success of sustainable organizations [18]. This matrix-based method isolates the interdependencies of various sustainability tasks, allowing each to prioritize maximizing revenue, minimizing costs, or supporting operations.

Table 3. Original matrix for production management or control to maximize return. The solution governs an organization to correspond to a variable process domain for solutions (adapted [19]), organizing production (OP) is primarily focused on maximizing revenue, production management/control (PMC) is centered on minimizing cost, and training & competence development (TCD) is geared toward supporting operations.

Sustainability tasks	Maximizing revenue	Minimizing cost	Operations
OP	X		
PMC		X	
TCD			X

The solution becomes as the decoupled version of the original integration matrix. The matrix focuses on decoupling, this arrangement ensures that each sustainability task contributes to a specific aspect of sustainable manufacturing, allowing for more targeted and efficient efforts in achieving long-term success and growth while emphasizing sustainability, is adjustable with different weights.

4 Discussion

In this research, we have explored the application of AD principles in business operations to enhance system-level sustainability and reduce unnecessary procedures. The primary focus is on improving organizational efficiency and long-term sustainability through the optimization of design matrices and organizational development [7]. This chapter discusses the key findings and implications of our research.

4.1 Key Findings

Our research has revealed several important insights into the application of AD principles in organizational development:

a) Early-stage prototype matrices for strategic options can help organizations focus on growth, performance, and customer value, enabling them to achieve their goals with minimal complexity [7].
b) Effective communication, quality control, and supplier integration are crucial factors for achieving customer-centered demand in organizational development.
c) Maximizing profits, turnover, and quality while minimizing product contamination involves incorporating process innovation and engaging competent employees in technology usage [7, 19].
d) Competency training is essential for developing a human resource vision that contributes to system and operations control [17].

e) Sustainability is a key consideration in refining complex systems and maximizing organizational performance [18].

4.2 Implications

The findings of our research have several implications for organizations and their approach to sustainability and efficiency. By building and managing an expert organization suitable for future Horizon financing and agile business support for continuous development. This implies:

1) AD can be applied across multiple domains, highlighting the potential for a more integrated and collaborative approach to organizational development [4].
2) AD optimizes organizational design parameters and acts as enabler for organizations to adapt and evolve existing systems more effectively, promoting the integration of organizational culture into business processes [5].
3) AD principles can facilitate the redesign of existing organizations or the implementation of new advancements in a systematic and goal-oriented manner [7].

4.3 Future Research Directions

Our research has provided valuable insights into the application of AD principles in organizational development. However, further research is needed to ensure the horizon management and applicant selection criteria among the agile organization development. We need to investigate:

a) the practical implementation of AD principles in product development contexts.
b) the potential limitations and challenges associated with the application of AD principles in organizations design processes.
c) the relationship between AD principles and other organizational development frameworks and methodologies.

4.4 Future research

Axiomatically designed, innovative organizations follow multifaceted design domains. Product-to-process design may be further developed in systems engineering, and efficiency practices require additional research into technology strategies. The organization's services within the customer interfaces are ecological practices in systems engineering. A supply chain simulation of the manufacturing operations of deterministic models matches those of sustainable operations.

4.5 Conclusions

In conclusion, sustainable organizations can achieve long-term success and growth by adopting a strategic approach that encompasses various aspects, such as production control, management, and competency development [7, 17, 18]. By utilizing a decoupled version of the sustainability matrix, organizations can effectively focus on specific sustainability tasks to maximize revenue, minimize costs, and support operations [18]. This matrix-based method facilitates a targeted approach to sustainable manufacturing, allowing for increased efficiency and adaptability in a competitive market environment. Regularly supplementing competitiveness and promoting continuous improvement further ensures the organization's sustainable growth and success.

In summary, our research has highlighted the potential benefits of applying AD principles in organizational development to improve system-level sustainability and efficiency. Future research should build upon our findings to further explore the practical implications and applications of these principles in various contexts.

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