PROCEEDING DTM FOR PLYWOOD

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ATLANTIS PRESS

Advances in Intelligent Systems Research, volume 171

1st International Conference on Engineering and Management in Industrial System (ICOEMIS 2019)

Defects Tracking Matrix for Plywood Industry Production based on House of Quality

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Keywords: Quality Control, Defect Tracking Matrix (DTM), Particle Board

Abstract. Problems in the industry with the mass customization system are quite complex because of the frequent reconfiguration by the changes of production process systems according to customer orders, so quality assurance is demanded to be more accurate according to the number of different part types and the interruption of the information flow about quality with each reconfiguration of the system. This study aims to build a model of quality control systems that are capable of detecting product defects by quickly adjusting changes in production lines according to customer desires. The method used to detect product defects is Defect Tracking Matrix (DTM). DTM connects manufacturing techniques with direct quality defects. This allows finding the cause of quality defects quickly. The quality control model that was built was applied to the Plywood Industry in Probolinggo, PT Kutai Timber Indonesia (KTI) in the Particle Board Division. Product variations are based on density, glue type, thickness, size, and wood type. There are 12 stages of the process in producing particle boards before being sent to customers. Product defects that often occur are in the cut to size and sanding process so that the specific DTM module is carried out in its. There are 12 stages of the production process of particle boards before being sent to customers. Product defects that often occur are in the Cut to Size and Sanding process so that the specific DTM module is carried out in its. There are 18 techniques attributes (TAs) that represent the manufacturing process module and 16 quality defects (QDs) in the Ply Wood Industry with sample of particle board process. The procedure of DTM is usefull to detect defect faster than usually).

Introduction

Consumer needs are increasingly diverse and unique, between consumers one with other consumers have differences, so companies need to be more responsive and flexible for customer satisfaction. To fulfill this, the mass customization production system is a system that is suitable for meeting changes that often occur in meeting products according to consumer needs. Production of various levels of production in a sustainable production cycle is known as mass customization. The aim of mass customization is to create products that are individually adjusted, with mass production volumes, costs, and efficiency, which most companies use 'assemble-to-order' configurations to create standardized products with mass customization, volume costs, and efficiency, and that more work is needed to achieve the goal of mass customization [1]. Quality Control for Mass Customization Production Systems (MCPS) needs to be developed to achieve this. There are two main tools for controlling the production process, namely statistical process control and maintenance management [2]. These methods are difficult to implement in MCPS because they require frequent reconfiguration to respond to changes in the sequence of production line operations. MCPS overcomes various types of changes, this requires different quality control systems than the systems used in mass production systems. To overcome this, the new Defect Tracking Matrix (DTM) tool, based on house of quality built for MCPS. DTM connects production process techniques with quality defects directly and increases the efficiency of tracking MCPS defects in a modular process. [3][4]. As a quality control tool, DTM has been used in several companies with the MCPS model.[5]

PT. Kutai Timber Indonesia (PT KTI) was established by a joint venture between Sumitomo Forestry Co., Ltd. Japan and the Fa. Kaltimex Jaya in 1970, whose main business was marketing and manufacturing plywood and wood products bases in Indonesia. PT KTI produces various products according to the customer's wishes. This requires that production systems often change the order of production processes because they adjust customer orders. PT KTI strives to become a producer of Plywood, Particle Boards and Wood Works with the best products, services, and prices that are suitable for the needs of people around the world, by producing high-quality Plywood, Particle Boards and Wood with competitive competition. The purpose of this study is to build a quality control system model in the Plywood Industry, PT KTI, which is able to detect product defects quickly, adjust changes in production lines to suit customer needs.

Literature Review

1. Mass Customization

Mass Customization (MC) aims to provide products and services according to the customer specification, both individual or niche groups of customer on a mass scale without losing the benefits of mass production. A number of studies about mass customization focus on the antecedents of MC capability, including modularity or internal, strategic orientations on MC capability [6], MC impact on BOM structure and MPS development [7]. Flexibility system for mass customization[8]. Meanwhile, performance of a production system depends on breakdown-free operation of equipment and processes. Maintenance and quality control play an important role in achieving this goal. At present, few studies focus on quality control in mass customization systems. Therefore, it is necessary to develop research on quality control in the mass customization system.

2. Defect Tracking Matrix

The method for quality defects tracking in plywood industry is DTM. In 2008, Hwa Wang & Ling create a new tool for quality control in mass customization production, called the defects tracking matrix (DTM), based on the House of Quality (HoQ) for quality defects tracking within a MCP modular process. The DTM connects manufacturing techniques with quality defects directly. The matrix may be used to improve MCP defect tracking efficiency within modular process.

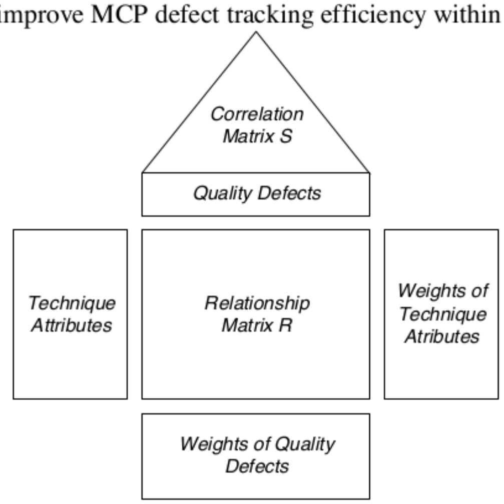


Fig. 1. Defect Tracking Matrix

There are five steps to construct a DTM in plywood industry production as follows[3] :

1. Representing the modular manufacturing process in plywood industry with the techniques attributes (TAs): There are i = 1 to m TAs, TAi. Weights of TAs are determined by manufacturing difficulty and costs. The weights of TAi (i = 1,2,...,m) are denoted by w(TAi) and they are determined by manufacturing difficulty and costs.
2. Determining the quality defects (QDs): More or less, every product has some quality defects. There are j = 1 to n QDs, QDj. Weights of QDs are determined by the severity of the defects affecting product quality. The weight of QDj (j = 1,2,...,n) are denoted by w(QDj) and they are determined by the severity of the defects affecting product quality.
3. Constructing the relationship matrix, R: The relationships are determined by estimating which TAs impact which QDs and up to what degree. If the improvement of a TA could deteriorate one of the QDs, their relationship is evaluated as positive; otherwise, their relationship is negative. Both positive and negative relationships are classified to three degrees, namely strong, medium, and weak. the integers 9, 3, 1, 0, -1, -3, -9 are used to express the relationships. When there is no relationship between TAi and QDj, Rij is assumed to be 0. When there is a strong positive relationships, Rij is assumed to be 9. When there is a medium positive relationship, Rij is assumed to be 3, and when there is a weak positive relationship, Rij is assumed to be 1; the negative relationships are set to -9, -3, or -1 according to their degree, respectively. Rij is determined by questionnaire from experts. Several experts fill out the questionnaires. We obtain Rij by calculating the average of the questionnaires.
4. Determining the weights of TAs and QDs using AHP: The Analytic Hierarchy Process (AHP) is a useful and systematic technique for acquiring feature weights and relationship coefficients from domain experts. After using the AHP approach, the weights of TAs and QDs can be identified.
5. Deduction of the correlation matrix, S: QDs' relationships are specified on an array known as 'the roof matrix' in HoQ. A correlation matrix is defined as follows:

$$S_{xy} = \sum_{i=1}^{m} [R_{ix}.w(TAi).(R_{iy,}w(TAi)] = \sum_{i=1}^{m} R_{ix}.R_{iy,}w^2(TAi), \quad x,y = 1,2,,n, x \neq y \ S = [S_{xy}] \tag{1}$$

   The relationship between pairs of QDs is conflicting when S_xy ≤0 and cooperative when S_xy ≥0. The correlation matrix S also indicates the strength of the relationships according to the absolute value of S_xy
6. DTM-chain construction is constructed by putting each module DTM's relationship matrix, R, in the diagonal of the big matrix as the production order.

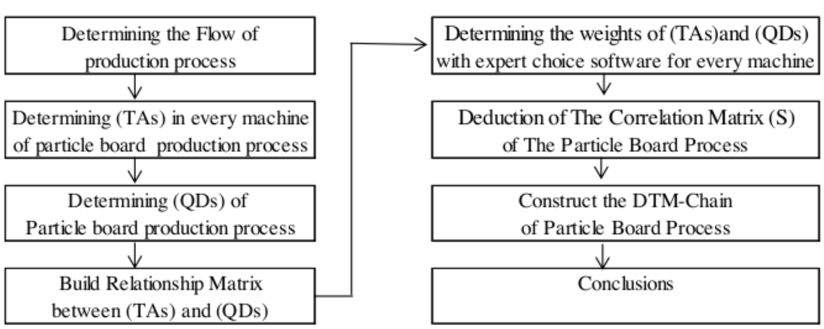


Fig. 2. Methodology

3. Expert Choice

In 1983, Dr. Saaty joined Dr. Ernest Forman, a professor of management science at George Washington University, to co-found Expert Choice. The AHP and Expert Choice software engage decision makers in structuring a decision into smaller parts, proceeding from the goal to objectives to sub-objectives down to the alternative courses of action. Decision makers then make simple pairwise comparison judgments throughout the hierarchy to arrive at overall priorities for the alternatives. Expert Choice is intuitive, graphically based and structured in a user-friendly fashion so as to be valuable for conceptual and analytical thinkers, novices and category experts. Because the criteria are presented in a hierarchical structure, decision makers are able to drill down to their level of expertise and apply judgments to the objectives deemed important to achieving their goals. At the end of the process, decision makers are fully cognizant of how and why the decision was made, with results that are meaningful, easy to communicate, and actionable. [9][10].

Result and analysis

Head office of PT KTI is in Jakarta, branch offices in Surabaya and Samarinda, and factory locations in Probolinggo. PT. KTI covers the marketing and manufacturing of various types of timber products where there are various kinds of activities in it, having 3 divisions namely: Plywood, woodworking, and particle board Division. Particleboard is a general term for panels made from lignocellulosic material (usually wood), especially in the form of separate pieces or particles, which are distinguished from fibers, combined with synthetic resins or other suitable binders and bonded together under heat and pressure in a hot press by a process in which all bonds between particles are made by added binders, and other materials which may have been added during manufacture to improve certain properties. In general, the flow of particle board production at PT. Kutai Timber Indonesia as follows:

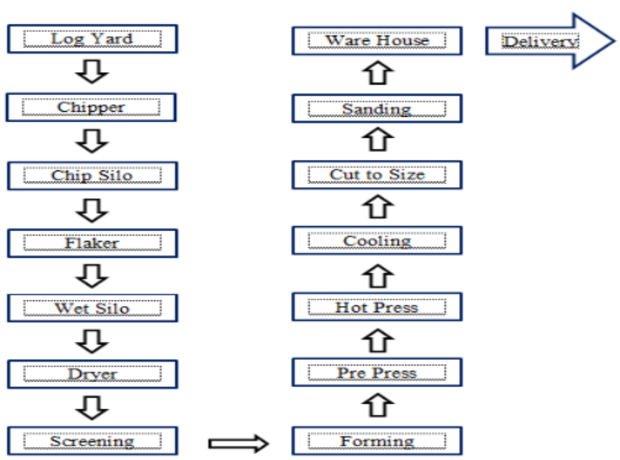


Fig. 3. The flow of Particle Board Process

Quality Control with mass customization approach is a good solution and suitable paradigm for particle boards, and the proposed approach of DTM and DTM chains is used to quality control for particle boards at PT KTI. Particle board specifications as follows:

Table 1. Specification of particle board.

NO	Item	Option		
		Reguler Boards	**Light Weight Boards**	**Light Weight Boards**
1	Width	1,220 mm	1,220 mm	1,220 mm
2	Length	1,830 mm;2,440mm	1,830 mm;2,440mm	1,830 mm;2,440mm
3	Thickness	9mm,12mm,15mm, 18mm, 25mm, 36mm	12mm,15mm,18mm, 25mm, 36mm	15mm,18mm, 25mm, 36mm
4	Glue Type	UREA	UREA	UREA
5	Emision	E1, E2, CARB P2	E1, E2, CARB P2	E1, E2, CARB P2
6	Density	Over 650 kg/m3	450-650 kg/m3	400-450 kg/m3
7	Wood Type	Meranti,Tropical, Plantation Hardwood,	Meranti,Tropical, Plantation Hardwood, Falcata	Meranti,Tropical, Plantation Hardwood, Falcata, Balsa

Following are the DTM steps for quality control on the particle board as follows :

a. Representing the modular manufacturing process with the techniques attributes: TAs, there are 18 Techniques Attributes for 4 process of particle board production as follows :

Table 2. Techniques attributes of The Particle board process.

FORMING MACHINE :			CUT TO SIZE		
TA1	is	DUST CONTENT	TA12	is	CIRCLE KNIFE
TA2	is	CLEANING DUCTING	TA13	is	SETTING PUSHER
TA3	is	SETTING SECTION	TA14	is	SETTING BLADE POSITION
TA4	is	SETTING BLOWER CLEANING SCREEN			
TA5	is	FORMING			
HOT PRESS			**SANDING MACHINE**		
TA6	is	SIMMING PRESS	TA15	is	SAND PAPER CHANGE
TA7	is	CALIBRATION PRESS	TA16	is	PLATTEN CHANGE SETTING RUBBER INPUT
TA8	is	INPUT TRANSDUSER	TA17	is	STACKER
TA9	is	HAMMERING	TA18	is	SENSOR TRACKING
TA10	is	CLEANING PROTECTION			
TA11	IS	CHANGE SEAL			

b. Determining quality defects, QDs: there are 16 quality defects for 4 procces of particle board production as follows :

Table 3. Quality Defects of The Particle board process.

FORMING MACHINE :			CUT TO SIZE		
QD 1	is	DUST SPOT	QD 9	is	ROUGH CUTTING
QD 2	is	ROUGH SURFACE	QD 10	is	DIAGONAL
QD 3	is	CORE SHOWING	QD 11	is	LENGTH
			QD 12		WIDTH
HOT PRESS			**SANDING MACHINE**		
QD 4	is	LESS SANDING	QD 13	is	CUTTER MARK
QD 5	is	THIN SPOT	QD 14	is	TIRUS
QD 6	is	CRACK	QD 15	is	SLOPING SANDING
QD 7	is	OIL STAINS	QD 16	is	PAPER STRIPE
QD 8	is	BLISTER			

c. Constructing the relationship matrix, R

Table 4. Relationship Matrix (R) of The Particle board process.

FORMING MACHINE	QUALITY DEFECT (QDs)		
	QD1	QD2	QD3
TA1	-9	-3	0
TA2	-9	-3	-3
TA3	-3	-3	-9
TA4	-9	-3	-3
TA5	-3	-9	0

CUT TO SIZE	QUALITY DEFECT (QDs)			
	QD9	QD10	QD11	QD12
TA12	-9	-3	-3	-3
TA13	0	-9	-3	-3
TA14	0	-3	-9	-9

HOT PRESS	QUALITY DEFECT (QDs)				
	QD4	QD5	QD6	QD7	QD8
TA6	-9	0	0	0	0
TA7	-3	0	-3	0	-3
TA8	-9	0	0	0	0
TA9	-1	-9	0	0	0
TA10	-3	-9	0	0	0
TA11	0	0	0	-9	-1

SANDING	QUALITY DEFECT (QDs)			
	QD13	QD14	QD15	QD16
TA15	-9	-3	0	-9
TA16	0	-9	-3	0
TA17	0	0	-9	0
TA18	-3	-1	-1	-9

d. Determining the weights of TAs and QDs

Through AHP, production supervisor, QC supervisor, and engineers within PT KTI worked together to decide the weights of TAs and QDs. We are using software supporting AHP, namely expert choice to determining the weight of TAS and QDs.

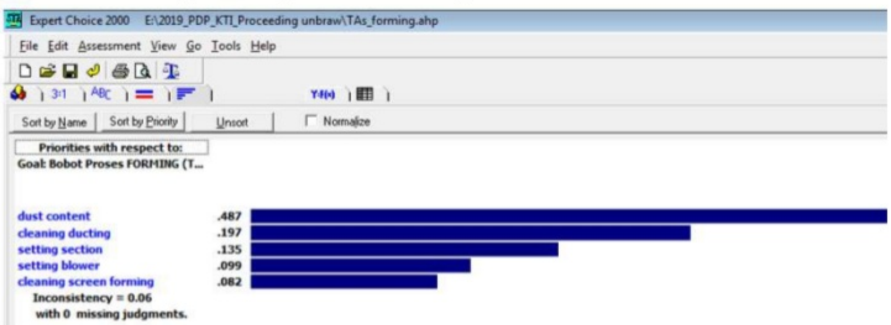


Fig. 4. The weight of TAs of Forming process

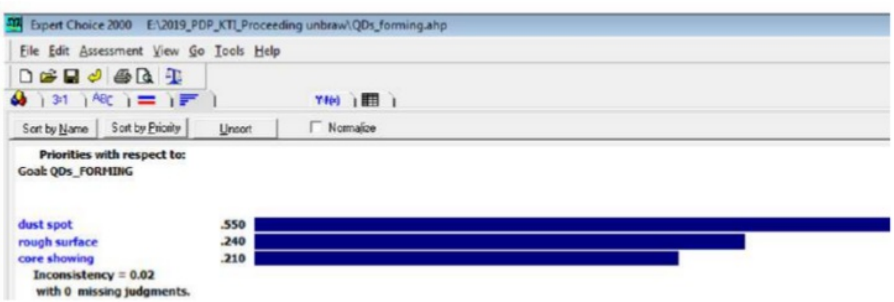


Fig. 5. The weight of QDs of Forming process

With the same ways, All process of particle board are determining the weights of TAs and QDs as follows:

Table 5. The weights of (Tas) and (QDs) of The Particle board process.

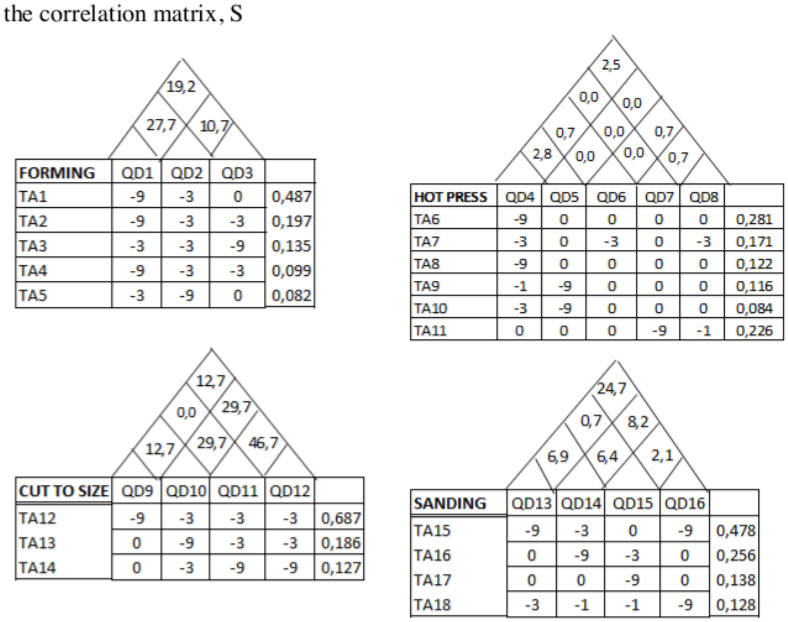
FORMING MACHINE	QUALITY DEFFECT (QDs)			w(TA)
	QD1	QD2	QD3	
TA1	0,273	0,143	0	0,487
TA2	0,273	0,143	0,2	0,197
TA3	0,091	0,143	0,6	0,135
TA4	0,273	0,143	0,2	0,099
TA5	0,091	0,429	0	0,082
w(QD)	0,55	0,24	0,21	

CUT TO SIZE	QUALITY DEFFECT (QDs)				w(TA)
	QD9	QD10	QD11	QD12	
TA12	1	0,2	0,2	0,2	0,687
TA13	0	0,6	0,2	0,2	0,186
TA14	0	0,2	0,6	0,6	0,127
w(QD)	0,436	0,247	0,159	0,159	

HOT PRESS	QUALITY DEFFECT (QDs)					w(TA)
	QD4	QD5	QD6	QD7	QD8	
TA6	0,36	0	0	0	0	0,281
TA7	0,12	0	1	0	0,75	0,171
TA8	0,36	0	0	0	0	0,122
TA9	0,04	0,5	0	0	0	0,116
TA10	0,12	0,5	0	0	0	0,084
TA11	0	0	0	1	0,25	0,226
w(QD)	0,386	0,22	0,166	0,085	0,143	

SANDING	QUALITY DEFFECT (QDs)				w(TA)
	QD13	QD14	QD15	QD16	
TA15	0,75	0,23	0,00	0,50	0,478
TA16	0,00	0,69	0,23	0,00	0,256
TA17	0,00	0,00	0,69	0,00	0,138
TA18	0,25	0,08	0,08	0,50	0,128
w(QD)	0,424	0,163	0,139	0,273	

e. Deduction of the correlation matrix, S



FORMING	QD1	QD2	QD3	
TA1	-9	-3	0	0,487
TA2	-9	-3	-3	0,197
TA3	-3	-3	-9	0,135
TA4	-9	-3	-3	0,099
TA5	-3	-9	0	0,082

HOT PRESS	QD4	QD5	QD6	QD7	QD8	
TA6	-9	0	0	0	0	0,281
TA7	-3	0	-3	0	-3	0,171
TA8	-9	0	0	0	0	0,122
TA9	-1	-9	0	0	0	0,116
TA10	-3	-9	0	0	0	0,084
TA11	0	0	0	-9	-1	0,226

CUT TO SIZE	QD9	QD10	QD11	QD12	
TA12	-9	-3	-3	-3	0,687
TA13	0	-9	-3	-3	0,186
TA14	0	-3	-9	-9	0,127

SANDING	QD13	QD14	QD15	QD16	
TA15	-9	-3	0	-9	0,478
TA16	0	-9	-3	0	0,256
TA17	0	0	-9	0	0,138
TA18	-3	-1	-1	-9	0,128

Fig. 6. The DTM and Correlation Matrix, S.

f. DTM-chain construction

	QD1	QD2	QD3	QD4	QD5	QD6	QD7	QD8	QD9	QD10	QD11	QD12	QD13	QD14	QD15	QD16
TA1	0,3	0,1	-													
TA2	0,3	0,1	0,2													
TA3	0,1	0,1	0,6													
TA4	0,3	0,1	0,2													
TA5	0,1	0,4	-													
TA6				0,4	-	-	-	-								
TA7				0,1	-	1,0	-	0,8								
TA8				0,4	-	-	-	-								
TA9				0,0	0,5	-	-	-								
TA10				0,1	0,5	-	-	-								
TA11				-	-	-	1,0	0,3								
TA12									1,0	0,2	0,2	0,2				
TA13									-	0,6	0,2	0,2				
TA14									-	0,2	0,6	0,6				
TA15													0,8	0,2	-	0,5
TA16													-	0,7	0,2	-
TA17													-	-	0,7	-
TA18													0,3	0,1	0,1	0,5

Fig. 7. The DTM-chain t of Particle Board Process

Conclusions

The application of the algorithm of DTM for quality control in plywood industry makes it easy for the quality control unit to carry out their duties, so the quality assurance of particle board can be done. The model that has been applied has overcome the difficulties in quality control on products that often change designs in the mass customization system by identifying the possibility of defects in each product module based on consumer desires and adjusting the sequence of production processes on DTM reconfiguration at the turn of the product.

Acknowledgements

We want to say thank you to the Ministry of Research and Technology's "DRPM" for the funds that have been given in the PDP Grant.

References

[1] S. Smith, G. C. Smith, R. Jiao, and C. H. Chu, “Mass customization in the product life cycle,” *J. Intell. Manuf.*, vol. 24, no. 5, pp. 877–885, 2013.

[2] D. Shrivastava, M. S. Kulkarni, and P. Vrat, “Integrated design of preventive maintenance and quality control policy parameters with CUSUM chart,” pp. 2101–2112, 2016.

[3] H. Wang and Æ. Z. Lin, “Defects tracking matrix for mass customization production based on house of quality,” no. 2007, pp. 666–684, 2008.

[4] H. Wang, “Defects tracking in mass customisation production using defects tracking matrix combined with principal component analysis,” *Int. J. Prod. Res.*, vol. 51, no. 6, pp. 1852–1868, 2013.

[5] Y.S. Tjahjaningsih, “Integrasi Failure Tracking Matrix berbasis house of quality dan FMEA untuk Pelacakan Kegagalan Proses pada sistem pemeliharaan,” *J. PASTI Univ. Mercu Buana*, vol. XIII, no. 1, 2019.

[6] Q. Wang, Z. Wang, and X. Zhao, “Strategic orientations and mass customisation capability: The moderating effect of product life cycle,” *Int. J. Prod. Res.*, vol. 53, no. 17, pp. 5278–5295, 2015.

[7] C. Chatras, V. Giard, and M. Sali, “Mass customisation impact on bill of materials structure

and master production schedule development," vol. 54, no. 18, pp. 5634–5650, 2016.
[8] S. A. Journal and I. E. May, "AN AUTOMATED FLEXIBLE FIXTURE SYSTEM FOR MASS CUSTOMISATION," vol. 29, no. May, pp. 21–34, 2018.
[9] S. Ali, J. Šaparauskas, and Z. Turskis, "Decision Making in Construction Management : AHP and Expert Choice Approach," *Procedia Eng.*, vol. 172, pp. 270–276, 2017.
[10] A. Ishizaka and A. Labib, "Analytic Hierarchy Process and Expert Choice : Benefits and Limitations," vol. 22, no. 4, 2009.

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