

KNOWLEDGE ACCELERATION ESTIMATOR (KAE) MODEL TO CUSTOMER BEHAVIOR USING BUSINESS METRICS

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ABSTRACT

Business Metrics in Financial Technology 1500 clients spread across North Sumatera Province. The effect of business advanced (business enterprise and social business) is enormous on clients who are as of now expanding in number. To create Knowledge Acceleration (KAE) Model utilizing Business Metrics on the effect of Commercial Entrepreneurship and Social Entrepreneurship in their use. Uncertainty emerging from manageable business administrators by considering parts of Business Metrics related. MARS a direct relapse investigation strategy nonparametric proposed for measurements with the point of encouraging examination and displaying the connections of each of the multi factors that emerge.

Keywords: *Finance Technology, Big Data Analytic, MARS, Business Canvas Model, Business Metrics.*

1. INTRODUCTION

The advancement of the 4.0 upheaval and we will experience the 5.0 upset, the improvement of computerized installment innovation keeps on developing alongside the increasing speed of information [2,3]. In this paper, course, it brings changes that significantly sway computerized organizations with the point of drawing in clients' enthusiasm for acquiring simple exchanges [6,7]. Nonetheless, the gatherings from the Banking controlled in Indonesia in the plan of the guideline that we call PBI (Bank Indonesia Regulation) in regards to money related innovation (FinTech) were set in 2017[4]. Guidelines on the administration of budgetary innovation that incorporates installment frameworks, showcase support, the executives venture and hazard the board, advances, financing and capital suppliers, and other money related help [5,6]. Shippers are gatherings of little business people as products/administrations that have a computerized business structure that works together with the Bank in giving installment receipt administrations by means of e-installment [12,13]. The job of the business visionary must have the option to see openings and difficulties just as the effect of income development in settling on choices and the rise of rivalry comprising of variation vendor prevalent items offered and client comfort [8,9]. In this research,

course there are endeavors to utilize business measurements, for example, benefits, salary and the financial exchange, to keep up business request to change the example of rivalry in creating nations [11]. Our exploration centers around information displaying by utilizing a non-parametric technique way to deal with client conduct in money related innovation. Multi Adaptive Regression Linear Spline (MARS) is one of the methodologies that we do by taking a gander at the connections and models among targets and expectations to be accomplished [1,2,3]. This technique is multi-duplicative to see the example and equalization of the numerous factors and sorts of potential outcomes in the Big Data Source that we use [1,4]. The rise of variation types and the quantity of comparative business entertainers must have the option to envision so as not to be occupied by the installment innovation mining [9,10]. In this way, we give a model of information speeding up approach in anticipating private venture entertainers by taking a gander at the parity and assorted variety of rivalry. This research before, was directed by (Weber et. Al, 2012) on the Big Data concentrate just as the MIGPORT study: a versatile application that runs as a "displaced person entrance", upheld by "Large Data Refugees Analytics": exiles send information to applications through "polls" and searching for

circumstances, the news consented to be privatized dependent on their answers.

Thoughts from the two sides of the help with Benefits made by Dominik can be an augmentation of Kjamli's substantial origination. Nshareplatform (NSP), will make an amicable open space for individuals with incapacities, they need comprehension and go after better correspondence of the "two capabilities" - Ability and Disability, and individual associates, who help individuals with inabilities). The role of the entrepreneur is freed from social impacts in

2. MATERIAL AND METHOD

Resources on Big Data right now information acquired all in all through an optional database that has been gotten from the Fintech application which we call "Client Behavior in FinTech". Be that as it may, there are multi-variety information that will be introduced, yet right now and see the type of examples from unstructured information, into organized information then the information will be prepared by the strategy way to deal with improve the data as delineated in the information base. Mobile Payment or M-Payment is a method of payment using a mobile phone or cellphone as a means. Mobile Payment widely known by mobile users is a banking product called Mobile Banking or M-Banking. Through M-Banking services we can check the balance of our savings account at the bank, transfer money, pay bills, as well as top-up credits.

2.1 Financial Technology

Financial technology is a combination of financial services and technology that eventually changes the business model from conventional to moderate [23]. People who originally had to meet face-to-face and bring a certain amount of cash to pay, can now make long distance payment transactions in just seconds.

Financial Technology (FinTech) is a combination of technology and financial service features that changes the business model and reduces the barrier to entry [24]. The implication for changing business models is that various financial services are carried out in a different

concept than before. Meanwhile, the barrier to entry is weakened, which is marked by the emergence of unregulated actors who can run services as regulated institutions.

developing and emerging countries consisting of social entrepreneurs who use business metrics such as profits, income and the stock exchange, to sustain social impacts in order to change the system in developing countries. Commercial entrepreneurs are generally oriented to use business metrics such as profits. Revenue and stock price increases. On the contrary, here we have a good non-profit or mixed social entrepreneur with a non-profit that generates a positive "return to society".

The development of Financial Technology provides the following opportunities and challenges to various parties:

1. Benefits for consumers: Expansion of product choices, improvement in service quality, price reduction
2. Benefits for business people: Shortening the transaction chain, increasing capital efficiency and operational resilience

Benefits for the economy: Speeding up the transmission of monetary policy, Increasing the speed of money supply and economic growth.

2.2 Demographics of Fintech users

The amount of Fintech user data in the last year (2019)

is shown in table 1.

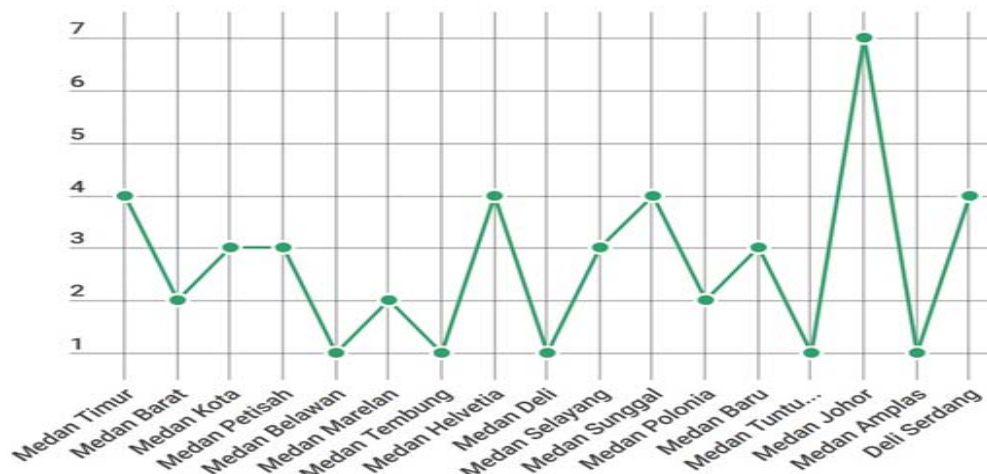


Figure 1. Growth District Fintech User Data

Table 1. Demographics of User in Fintech

City/District	Frequency	Percentage
Kota Medan	920	66,52%
Deli Serdang	227	16,41%
Kota Pematangsiantar	77	5,57%
Kota Binjai	27	1,95%
Simalungun	16	1,16%
Langkat	15	1,08%
Kota Tebingtinggi	12	0,87%
Serdang Bedagai	12	0,87%
Asahan	8	0,58%
Kota Padangsidimpuan	7	0,51%
Karo	6	0,43%
Labuhanbatu Utara	6	0,43%
Tapanuli Tengah	6	0,43%
Labuhanbatu	5	0,36%
Tapanuli Selatan	5	0,36%
Kota Gunungsitoli	4	0,29%
Batu Bara	3	0,22%
Dairi	3	0,22%
Kota Sibolga	3	0,22%
Labuhanbatu Selatan	3	0,22%
Tapanuli Utara	3	0,22%
Toba Samosir	3	0,22%
Humbang Hasundutan	2	0,14%
Nias Barat	2	0,14%
Padang Lawas Utara	2	0,14%
Danau Toba	1	0,07%
Mandailing Natal	1	0,07%
Nias	1	0,07%
Nias Utara	1	0,07%
Padang Lawas	1	0,07%
Samosir	1	0,07%

Table 1. data of Fintech users is taken from North Sumatra Province which is spread in 33 regencies/cities, totaling 1,383 thousand. User behavior can also be seen from each regional distribution as outlined in table 3.1 where user behavior varies greatly. The number of users is very significant in Medan City, which is 920

users, while in other regencies and cities the number of users ranges from 1 - 200, such as Deli Serdang with 227 users. In percentage, the frequency of Fintech users in Medan is 66.52%. Whereas in other regencies and cities it is in the range of 0.07 - 16.41%.

2.3 Demographics of Merchants and Billers in FinTech

Table 2. Demographics of Merchants in FinTech

Merchant Name	Frequency	Amount
SATE BANG JON LK	30	720.000
TOKO DEDI LK	25	307.000
IBRAHIM YUSUF	24	702.500
WARUNG SIMPANG TIGA	23	373.000
MILALA BENGKEL	16	447.500
IR.ONE S	14	180.000
WARUNG TIARA LK	14	276.500
RUJAK JELANI	13	314.001
MARIANA BR SINAGA	12	155.000
ABU BAKAR NL	9	115.000
FRANS PEBRIAN LUBIS	7	87.000
SOSIS GORENG ALKUDUS NL	6	75.000
ANEKA GORENGAN NL	4	47.500
KFC Adam Malik Medan	4	36.000
BUBUR AYAM BPK SUPARMAN	3	41.500
BURGER BU NENG LK	3	40.000
KFC CENTER POINT MEDAN	3	27.000
KFC SETIABUDI HOME CENTRA	3	32.000
KFC Simpang Mataram Medan	3	21.000
RUJAK JELANI - 100105063924	3	56.000
SOTO FRISKA LK	3	37.000
WARUNG BIBI LK	3	34.000

WARUNG JOKO LK	3	35.000
BENNY NATANAEL SINAGA	2	41.500
KFC Asia Mega Mas Medan	2	13.000
KFC Btc Mareland	2	14.000
PERCETAKAN EKA	2	22.000
RM RENI	2	22.000
TOKO BAYU LK	2	25.000
TOKO ELYA LK	2	55.000
WARKOP RADOEL LK	2	22.000
WARUNG JUSS PAK YADI LK	2	13.000
APOTEK MAJU LK	1	15.000
FRISTI CELL NL	1	10.000
GALON RENDI LK	1	10.000
INDOMARET	1	4.200
KEDE JON NL	1	25.000
KFC Cemara Asri Medan	1	6.500
MIE ACEH ANDRE	1	15.000
MIE AYAM PALANGKARAYA	1	15.000
POP ICE WANTI	1	3.000
SALES MEDAN 3 ZULVAN -	1	12.000
SALES MEDAN 3 ZULVAN SUHADA	1	10.000
SAMBELAN BU SRI	1	13.000
SITI AMINAH	1	10.000
TOKO GINTING LK	1	15.000
WARUNG ABAS LK	1	15.000
WARUNG EYANG LK	1	5.500
WARUNG FIRDAUS	1	15.000

Table 2. shows that the user behavior that is in great demand is the "SATE BANG JON LK" merchant, by looking at the number of behaviors that arise involving 30 users, such as merchants "STORAGE SIMPANG THREE", "RUJAK JAELANI", "BURGER BU NENG LK". The competitiveness of each merchant (1 - 25) is very varied. User transactions with the merchants also differ depending on the level of sales items. So, merchants need to anticipate the emergence of disruption due to the increasing number and variety of competitors.

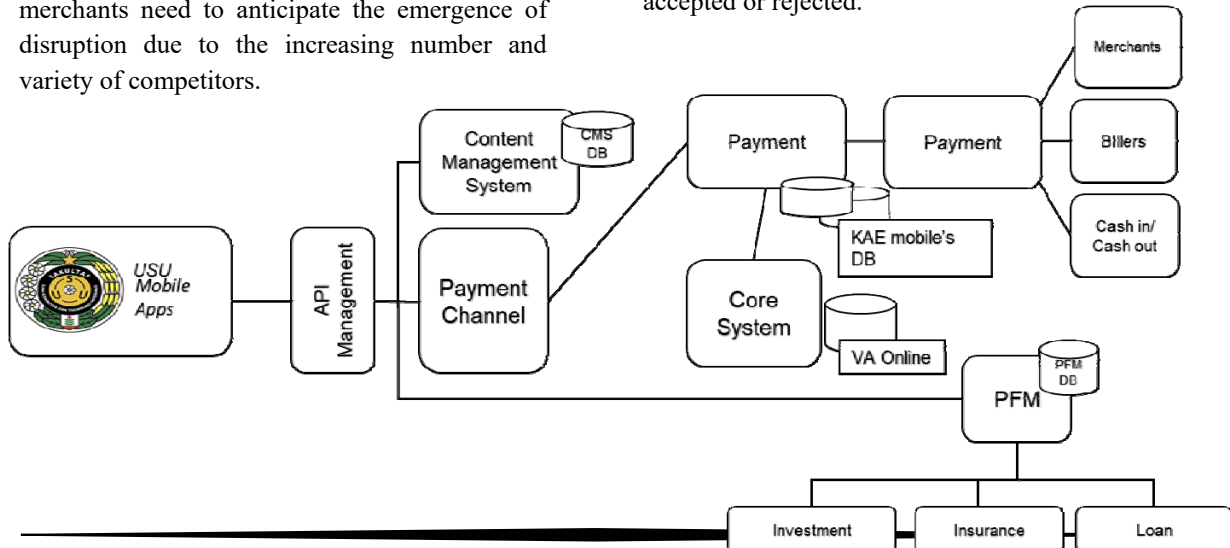


Figure 1. KAE to Business Metrics Architecture Payment Model

for managing very diverse user behavior. The goal is to keep the business sustainable and the challenges of digital business development be met. Table 2.3 shows user behavior towards biller, namely: Merchant : is a place that accommodates customer transaction details. The data includes static and dynamic elements that identify each transaction.

2.4 KAE to Business Metrics Payment Model

- a) Customers receive transaction data from the Merchant and match each information they have in which the standard payment format has been prepared to be able to process payments[5,6]. The payment process is via trusted partners such as a bank or telecommunications operator. When the payment request is ready to be transferred, the consumer checks and identifies with the PIN sent by the account manager.
- b) The account manager will accept payment requests, identify customers and process payment requests. The identification process includes checking available funds and the amount requested [13,17]. When the process is complete, the payment notice is forwarded to the data center as a payment service. The data set then identifies the address of the bank/telco operator at the payment notice and then sends a message to the merchant to notify that the payment process has taken place[14].The processor on the merchant side accepts the payment notice and provides real-time notification on whether the transaction is accepted or rejected.

2.5 Personal Financial Management (PFM)

- a. Assessment of personal financial analysis
- b. Assessment of Personal financial health

2.6 Model Knowledge Acceleration Manage Service Mobile Apps

Manage pros e-money merchants work as usual, namely serving their customers according to the rules of the system set by the bank. The first step taken by prospective merchants is to register first as a partner by submitting the required data correctly. This data will automatically be stored in the company database as an ID that indicates that the merchant has officially cooperated by first agreeing to the terms and conditions of the company. After the

- c. Financial Product recommendation service consisting of Investment and Insurance products. Tools to monitor and control the level of expenditure to meet the customer's financial planning goals.

registration process is complete, the merchant now has a virtual office that functions as a mediator in receiving virtual discount transactions and virtual currencies transferred by prospective buyers. In this case the identity of the buyer will be easily recognized by the merchant because both parties already know how much the virtual discount or virtual currency will be transferred to the merchant's virtual office. The next step is the Merchant directly sends the product in the form, amount and shipping cost agreed by both parties.

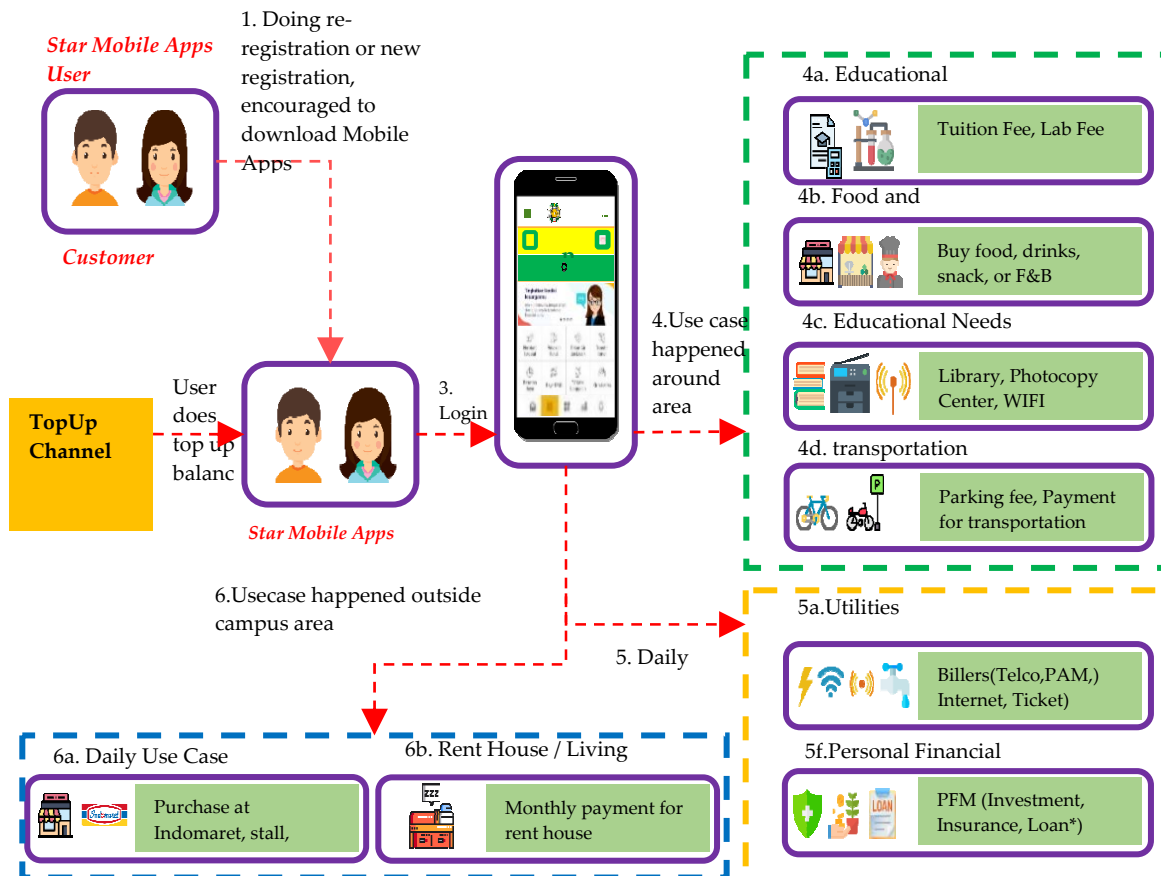


Figure 2. Knowledge Acceleration Manage Service Mobile Apps

Figure 2. we do the six stages, from our application approach we get the behavior of user habits that tend to be often done towards the use

of financial technology [7,9]. We accelerate the Knowledge base in the average transaction and efficiency comparison between existing merchant competitive [2,3]. By determining the

probabilities that arise and the various variants, we use MARS to determine the target variable (Y) and predictor (x).

In general, merchants work as usual, namely serving their customers according to the rules of the system set by the bank [15,16]. The first step taken by prospective merchants is to register first as a partner by submitting the required data correctly [17,18]. This data will automatically be stored in the company database as an ID that indicates that the merchant has officially cooperated by first agreeing to the terms and conditions of the company [4]. After the

registration process is complete, the merchant now has a virtual office that functions as a mediator in receiving virtual discount transactions and virtual currencies transferred by prospective buyers. In this case the identity of the buyer will be easily recognized by the merchant because both parties already know how much the virtual discount or virtual currency will be transferred to the merchant's virtual office. The next step is the Merchant directly sends the product in the form, amount and shipping cost agreed by both parties.

Tabel 3. Business Metrics variant of Value Transaction

Business Metrics	Value Transaction
<i>Variant Transaction</i>	1500; 3000; 3001; 4200; 5500; 6500; 7000; 8000; 9000; 9500;10000; 12000; 13000; 14500; 15000; 16000; 18500; 19000;20000; 24000; 25000; 27500; 29500; 30000; 31000; 36000;40000; 42500; 45000; 48000; 50000; 60000; 70000; 72000;75000; 85000; 90000; 100000; 140000; 185000
<i>Name Merchant</i>	ABU BAKAR NL; ANEKA GORENGAN NL; APOTEK MAJU LK; BENNYNATANAEL SINAGA; BUBUR AYAM BPK SUPARMAN; BURGER BUNENGLK; FRANS PEBRIAN LUBIS; FRISTI CELL NL; GALON RENDI LK; IBRAHIM YUSUF; INDOMARET; IR.ONE S; KEDE JON NL; KFC Adam Malik Medan; KFC Asia Mega Mas Medan; KFC Btc Mareland; KFC Cemara Asri Medan; KFC CENTER POINT MEDAN; KFC SETIABUDI HOME CENTRA; KFC Simpang Mataram Medan; MARIANA BR SINAGA;MIEACEH ANDRE; MIE AYAM PALANGKARAYA; MILALA BENGKEL;PERCETAKAN EKA; POP ICE WANTI; RM RENI; RUJAK JELANI;RUJAKJELANI-SALES MEDAN 3 ZULVAN -; SALES MEDAN 3ZULVAN SUHADA; SAMBELAN BU SRI; SATE BANG JON LK; SITI AMINAH; SOSIS GORENG ALKUDUS NL; SOTO FRISKA LK; TOKOBAYULK; TOKO DEDI LK; TOKO ELYA LK; TOKO GINTING LK; WARKOPRADOEL LK; WARUNG ABAS LK; WARUNG BIBI LK; WARUNG EYANGLK;WARUNG FIRDAUS; WARUNG JOKO LK; WARUNG JUSS PAKYADILK;WARUNG SIMPANG TIGA; WARUNG TIARA LK

Electronic-based business continues to generate novelty, partnership types, and new ways to get success. Thus, to keep abreast of developments, companies need to approach a nonparametric model to calibrate business success and sustainability. An indicator of e-business effectiveness in this case is whether a company

- Market Capitalization,
- Price to income ratio,
- Fixed assets,
- Typical flows,
- Goods turnover,
- Net income,

is producing the desired results. Traditional Business Metrics often provide a more stable and accurate flow of financial report calculations that can be used by companies. The following types of business metrics reports can be used by the company as a whole:

- g) Customer turnover,
- h) Market share,
- i) The balance ratio between bills in a typical book
- j) Industrial sector growth

Based on statistical data on the population of the Province of North Sumatra, 14 million people are in 33 regencies/cities and the growth of **2.7 Multivariate Adaptive Regression Linear Spline (MARS)**

The special advantage of MARS lies in its ability to estimate the contribution of BF so that additional and interactive effects of predictors are allowed to predict response variables [1,2,3]. MARS is a nonparametric regression procedure that does not make specific assumptions about the underlying functional relationships between dependent and independent variables to estimate the general function of high-dimensional arguments, given the sparse data.

$$[+(x - T)]_+ + [-(x - T)]_+ \quad (1)$$

where $[q]_+ = \max \{0, q\}$ and τ are univariate vertices. Each function is linear, with a node at the value of r , and the corresponding pair of functions is called the reflected pair. Let us consider a general model of the relationship between predictor variables and responses. The goal is to build the pair that is reflected for each predictor x_j ($j = 1, 2, \dots, p$) with the p -dimension knot $\tau_i = (\tau_{i,1}, \tau_{i,2}, \dots, \tau_{i,p})^T$ at $x_i = (x_{i,1}, x_{i,2}, \dots, x_{i,p})^T$ or just adjacent to each data vector $\hat{x}_i = (\hat{x}_{i,1}, \hat{x}_{i,2}, \dots, \hat{x}_{i,p})^T$ ($i = 1, 2, \dots, N$) of the predictor. We do not lose the generality, the assumption that $\tau_{i,j} \neq \hat{x}_{i,j}$ for all i and j , to prevent the difference in the matter of optimizing this research later[1]. Actually, we can choose node $\tau_{i,j}$ further than the predictor value $\hat{x}_{i,j}$, if there is a position that promises better data mounting[1]. After this preparation, the BF collection of research is:

$$\theta_j \{ (x_j - T)_+ + (T - x_j)_+ + |T \in \{x_{i,1}, x_{i,2}, \dots, x_{i,p}\}, j \in \{1, 2, \dots, p\} \} \quad (2)$$

So, we can represent $f(x)$ with linear combinations which are respectively built by the set p and with the intercept θ_0 , so that (2) takes the form.

$$y = \theta_0 + \sum_{m=1}^M \theta_m \psi_m(x) + \epsilon \quad (3)$$

Here, ψ_m ($m = 1, 2, \dots, M$) is the BF of p or the product of two or more of these functions, ψ is taken from a set of linear independent basis elements M , and θ_m is an unknown coefficient for m -basis functions ($m = 1, 2, \dots, M$) or for constants 1 ($m = 0$). One set of vertices that satisfies i, j is assigned separately for each

merchants has reached 21,000. This study used data from the last 3 years that show the behavior of FinTech users and e-metrics online data.

dimension of the predictor variable and is chosen so that it coincides with the level of predictor represented in the data. BF interactions are made by multiplying existing BF with truncated linear functions involving new variables. In this case, the existing BF and the newly created BF interaction are used in the MARS approach [1]. Provided that observations are represented by data x_i, y_i ($i = 1, 2, \dots, N$), the BF to m form can be written as follows:

$$\psi_m(x) = \prod_{j=1}^{K_m} [S_{K_j^m} \cdot (x_{K_j^m} - T_{K_j^m})]_+ \quad (4)$$

where K_m is the number of truncated linear functions multiplied in the BF to m , $x_{K_j^m}$ is the predictor variable corresponding to the j intersecting the linear function in the BF to m , $T_{K_j^m}$ is the node value corresponding to the variable, $x_{K_j^m}$ and $S_{K_j^m}$ is the chosen sign +1 or -

$$GCV = \frac{1}{N} \frac{\sum_{i=1}^N (y_i - \hat{f}_m(x_i))^2}{(1 - c(\alpha)/N)^2} \quad (5)$$

The MARS algorithm for estimating the function model $f(x)$ consists of two sub-algorithms: The stepwise forward algorithm looks for BF and at each step, a split that minimizes the 'less suitable' criteria of all possible separations for each BF is selected [2,3]. The process stops when the user-specified M_{max} value is reached. Then, the stepwise backward algorithm begins to prevent excess conformity by reducing the complexity of the model without reducing conformity to the data, and to eliminate from the BF model that contributes to the smallest increase in residual error squares at each stage, producing optimally estimated models with respect to each the number of terms, called f_α . This study notes that reveals some estimation complexity [3]. To estimate the optimal α value generalized cross-validation (GCV) can be used, indicating a lack of conformity for the MARS model.

3. RESULT AND DISCUSSION

In this paper, Data used to solve real life problems is discrete. Data modelling, also called a discrete or Knowledge Acceleration Model approach, is widely used to establish

response variables [2,3]. There are various forms of regression models, each of which is used for different purposes such as data description, summarization, parameter estimation for learning and control, in almost every field of

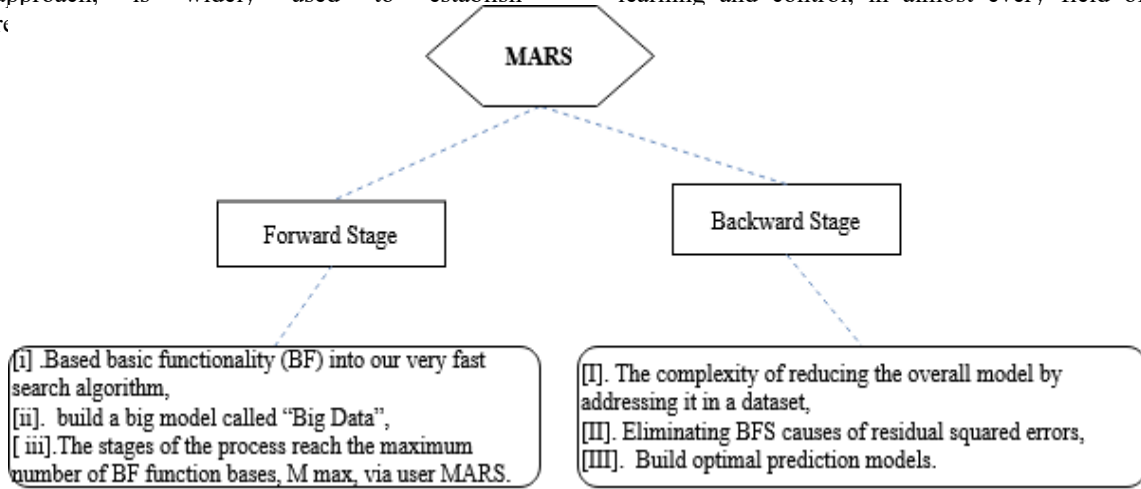


Figure 3. The Two-Stage Process In MARS

In Figure 3. we adopt the denotation of the linear 1- dimensional piecewise BFS expressed in the equation. MARS Model, the optimal estimated model with the amount reduced by BF and max M is the Forward and Backward Phase of the MARS by its software, with the help of general-cross

validation (GCV) which is given the best predictive optimal and selected optimal model [1,2,3]. However, Forward Stage of MARS, the highest level of interaction (max. M) and BF of the relationship are assigned, BFs on the Backward Stage are represented as follows:

Algorithm for Basis Function MARS Method:

- BF1= max {0, x₂-0.251038} (merchant\$ = .);
- BF3= max {0,007, x₆- 186917} BF₁ (name merchant\$ is in SubSet1);
- BF5= max {0, x₉-0,1272981} .BF₂ (name_ merchant \$ is in SubSet2);
- BF7= max {0, x₂-0.8,68922} .BF₆ (name_ merchant \$ is in SubSet3);
- BF9= max {0, x₂+ 0.631769} BF₈ (name_ merchant \$ is in SubSet4);
- BF11= max {0,008x₂-0.370786E-008} BF₁₂ (name_ merchant \$ is in SubSet5);
- BF13= max {0, x₂+0.404497} BF₁₄ (name_ merchant \$ is in SubSet6);
- BF15= max {0, x₂-1500} max (0, value transaction - 1500);

The optimization MARS model with the BFs above is presented in the subsequent form:

$$0.631769 -008 + BF11 - 0.370786-008 + BF13 + 0.404497-013 + BF15;$$

$$Y = \theta_0 + \sum_{m=1}^M \theta_m \psi_m(x) + \epsilon = 0.309448 - 0.007 + 1 + BF1 - 0.251038 -007 + BF3 - 0.186917- 007 + BF5 + 0.127298-007 + BF7 - 0.868922-008 + BF9 +$$

Description of the variables that are built based on the implementation of the MARS method, our estimates are randomly starting from the determination of the dependent and independent variables. From the results of this trial as follows:

Table 4. Learning Calculation Results

Name	Learning Statistics
RMSE	0.114
MSE	0.131
GCV	0.139
MAD	0.363
GCV R-Sq	0.362

Assessment of statistical calculations or agreed upon statistics, announced in Table 3.1, to approve the results of the proposed model. This research, Mean Square Error (MSE), Root Mean Square Error (RMSE), general cross validation (GCV), accuracy to measure the predictive ability of each model. Therefore, the

accuracy criteria indicate which model has higher predictive ability than the others accuracy to measure the ability of each model. Therefore, the criteria prove which model has the ability more than others and which one is the best.

Table 5. Mars Data Training Data Model Results

Percentile	N	R ²	MSE	MAD	RMSE	MRAD
99,86%	710	0,47430	0,948785	0,40921	0,64099	0,24077
99,30%	706	0,60465	0,963248	0,95256	0,13885	0,23758
98,59%	701	0,68651	0,247041	0,61566	0,76602	0,23419
96,48%	686	0,79909	0,331950	0,10234	0,16316	0,20633
92,97%	661	0,86207	0,927621	0,70673	0,45363	0,14726
85,94%	611	0,94398	0,146530	0,05022	0,26859	0,08226

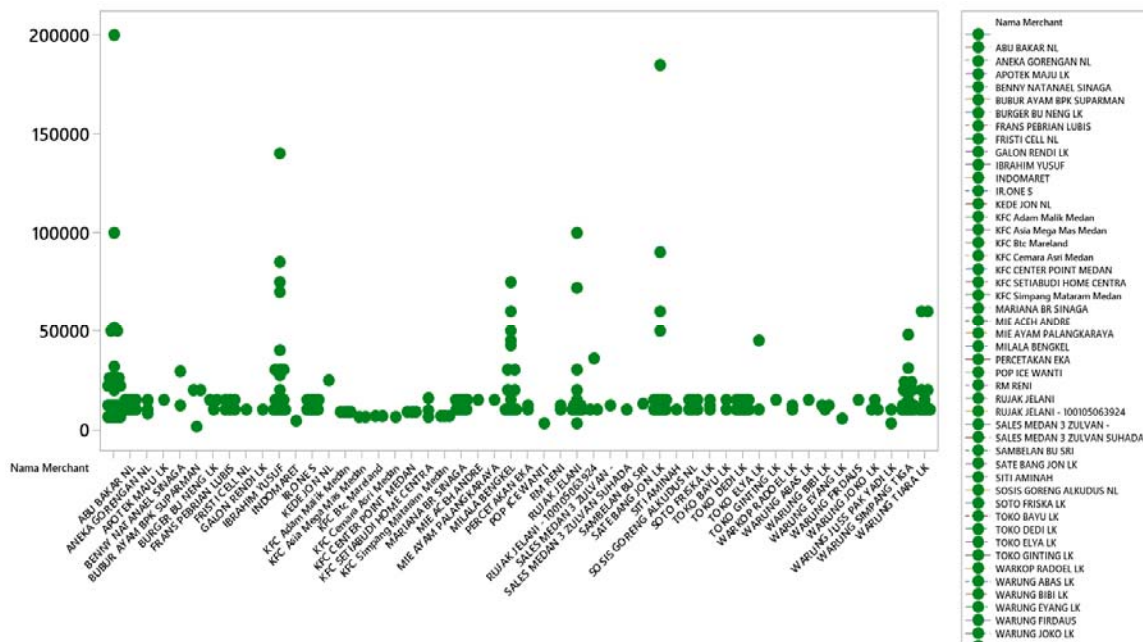


Figure 4. Result Customer Behaviour Growth On Merchants Ecosystem

4. CONCLUSION AND FUTURE WORK

The results of this study, that in general intense competition in the diverse merchant ecosystem, it is necessary to anticipate challenges and opportunities through the MARS method approach and Knowledge Acceleration, with the aim of maximizing sustainable business decisions. With this optimization method, businesses must take steps so as not to be distracted by opening new business opportunities. In this paper data model result percentage 85,94 until 99,86. In future work, can utilize different strategies, for example, Generalized Partial Linier Model, Robust GPLM, so to foresee clients of money related information measurements will be better.

REFERENCES

- [1] G-W Weber, I. Batmaz, G. Koksall, P. Talyon, and F. Yerlikaya (2011). *CMARS: A New Contribution to nonparametric regression with Multivariate Adaptive Regression Splines Support by Continuous Optimization, Inverse Problem and Science and engineering*, DOI:10.1080/17415977.2011.624770.
- [2] Graczyk-Kucharska, Magdalena & Szafranski, Maciej & Gutmen, Selma & Cevik, Alper & Weber, Gerhard-Wilhelm & Włodarczyk, Zbigniew & Goliński, Marek & Özmen, Ayşe. (2019). *Modelling Problems in a Regional Labor Market in Poland with MARS*.
- [3] Graczyk-Kucharska, Magdalena & Özmen, Ayşe & Szafranski, Maciej & Weber, Gerhard-Wilhelm & Goliński, Marek & Sychała, Małgorzata. (2019). *Knowledge accelerator by transversal competences and multivariate adaptive regression splines*. Central European Journal of Operations Research. 10.1007/s10100-019-00636-x.
- [4] R. Syah, M. K. M. Nasution, E B Nababan, S Efendi. (2019). *Optimization Metrics Model: The Mobile Wallet for Merchant Ecosystem*. International Conference on Computational Science and Information Management (ICCAI).
- [5] S. T. Asah, A. D. Guerry, D. J. Blahna, J. J. Lawler. (2014). *Perception, acquisition and use of ecosystem services: Human behavior, and ecosystem management and policy implications*. *Ecosystem Services*. **10**, 180–186. *The FinTech Book* (John Wiley & Sons, Ltd, Chichester, UK, 2016).
- [6] Kim, Y. & Lee, Y. A Study on the Consumers' Perceptions and Behavioural Characteristics toward Fashion Products in Omni-channel Retailing. *Journal of the Korean Society of Clothing and Textiles* 41, 170–183 (2017).
- [7] F. Amato et al., in *Smart Innovation, Systems and Technologies* (Springer Science and Business Media Deutschland GmbH, 2019), vol. 98, pp. 53–63.
- [8] T. Zhou, An empirical examination of continuance intention of mobile payment services. *Decision Support Systems*. 54, 1085–1091 (2013).
- [9] C. Tat Huei, L. Suet Cheng, L. Chee Seong, A. Aye Khin, R. Ling Leh Bin, Preliminary Study on Consumer Attitude towards FinTech Products and Services in Malaysia. *International Journal of Engineering & Technology*. 7, 166 (2018).
- [10] K. Mahyuddin, M. Nasution, M. Elveny, R. Syah, S. A. Noah, in *Proceedings - 5th International Conference on Electrical Engineering and Informatics: Bridging the Knowledge between Academic, Industry, and Community, ICEEI 2015* (Institute of Electrical and Electronics Engineers Inc., 2015), pp. 496–499.
- [11] Yonghee Kim, Jeongil Choi, Young-Ju Park, JiyoungYeon (2016). *The Adoption of Mobile Payment Services for "Fintech"*. *International Journal of Applied Engineering Research* ISSN 0973-4562 Volume 11, Number 2 (2016) pp 1058-1061.
- [12] Kang, J. Mobile payment in Fintech environment: trends, security challenges, and services. *Hum. Cent. Comput. Inf. Sci.* 8, 32 (2018). doi:10.1186/s13673-018-0155-4.
- [13] Carmen Leonga, Barney Tanb, Xiao Xiaoc, Felix Ter Chian Tana, Yuan Sund (2017). *Nurturing a FinTech ecosystem: The case of a youth microloan startup in China*. <https://doi.org/10.1016/j.ijinfomgt.2016.11.006>
- [14] Pandian Vasant, 2006; Fuzzy decision making of profit function in production planning using S-curve membership function, *Computers & Industrial Engineering*, Volume 51, Issue 4,, Pages715-725; <https://doi.org/10.1016/j.cie.2006.08.017>;

- [15] B Kjamili & G-W Weber (2017). The Role of Liberated Social Entrepreneur in Developing Countries: A mid-way, in Societal Complexity, Data Mining and Gaming; State-of-the-Art 2017, Greenhill & Waterfront, Europe: Amsterdam, The Netherlands; Guilford, UK North-America: Montreal, Canada, 2017. ISBN /EAN 978-90-77171-54-7. F.
- [16] Amato et al., in Smart Innovation, Systems and Technologies (Springer Science and Business Media Deutschland GmbH, 2019), vol. 98, pp. 53–63.
- [17] Pandian M. Vasant¹, and Madi A. Muhd, 2006. Fuzzy Production Planning and Its Application to Decision Making; Journal of Intelligent Manufacturing; Kluwer Academic Publishers.
- [18] J. Leskovec et al., in Mining of Massive Datasets (Cambridge University Press, 2014), pp. 325–383.
- [19] S. L. Lim, P. J. Bentley, N. Kanakam, F. Ishikawa, S. Honiden, Investigating country differences in mobile app user behavior and challenges for software engineering. IEEE Transactions on Software Engineering. 41, 40–64 (2015).
- [20] Cruz-Benito, J., Therón, R., García-Peñalvo, F. J. & Pizarro Lucas, E. Discovering usage behaviours and engagement in an Educational Virtual World. Computers in Human Behavior 47, 18–25 (2015).
- [21] Nasution, Mahyuddin. (2017). Modelling and Simulation of Search Engine. Journal of Physics: Conference Series. 801. 012078. 10.1088/1742-6596/801/1/012078.
- [22] M K M Nasution. 2019. Information Retrieval Optimization Based on Tree of Social Network. IOP Conf. Series: Materials Science and Engineering 505 (2019) 012099. doi:10.1088/1757-899X/505/1/012099.
- [23] Syah, B.R., Elveny, M., Nasution, M.K.M., Arbie, H. and Siregar, M.A., Future of Fintech: The Mobile Payment Architecture Model Using Personal Financial Management (PFM).
- [24] R Syah, M.K.M Nasution, E B Nababan, S Efendi. Optimization Tree Based Inference to Customer Behaviors in Mobile Payment. IOP Conf. Series: Materials Science and Engineering (ITEM 2020).