

Towards a Comprehensive Exploration and Mapping of Maturity Models in Digital Business: A Systematic Literature Review

Arfive Gandhi* and Yudho Giri Sucahyo

Faculty of Computer Science, Universitas Indonesia, Depok 16424, Indonesia

**E-mail: arfive.gandhi@ui.ac.id*

ABSTRACT

Many Maturity Models (MM) in digital business were difficult to be implemented and adopted in real world due to lack of validation. In order to solve the theoretical gap, this study conducted Systematic Literature Review (SLR) to generate comprehensive exploration and mapping of MM. Out of 179 articles captured using Scopus, 28 articles were eligible. Using Kitchenham et.al's SLR phases, this study classified type, schemes, and technique on MM creation. Nine research method attributes were employed: referred methodologies, hierarchical type, maturity status, cascading scheme, leveling, criteria sources, classification scheme, implementation technique, and evaluation/verification/validation technique. Moreover, this study provided rationalisation on each alternative so that acceptance of MM can be increased.

Keywords: Maturity model; Digital business; Systematic literature review; Kitchenham

1. INTRODUCTION

Maturity model (MM) has become promising research topic on information technology/information systems (IT/IS) domain. Many practitioners believed it as a tool to assess the current state of an object and know how to improve it towards the expectation. Scopus recorded its positive trending refer to 2,582 articles include 'maturity model' as keywords during 2001 until 2019. This growth portrayed MM popularity.

Generally, MM brings some beneficial advantages. First, organisations use MM to appraise its ongoing maturity¹, both on governance and technical aspects. In several MMs, organisations receive comprehensive landscape according to the scope and dimensions². Second, it gives guidance to the organisation in improving its long-term goal³. Third, gap analysis between its ongoing maturity and expected long-term goal will deliver pathway to achieve target³. Fourth, it enables objective comparison among organisations. Fifth, it converses tacit knowledge about current and future states into explicit knowledge that can be understood by all stakeholders. Therefore, organisation can analyse, plan, and plot its progression⁴ with necessary resources. Finally, organisation can formulate its priority on data, people, processes, and technology in the roadmap.

This study captured theoretical gap on research about MMs. Becker et.al declared that authors in MM research rarely reveal motivation⁵. Moreover, they found lack of description on procedural method and evaluation results⁵⁻⁶. Mettler et.al also spoke that most of MM research's also lack of validation⁷.

Lack of validation became repeated issue on MM development as said by Tarhan et.al⁸. Some prior research had tried to identify how MMs were validated using comprehensive methods, such as in Shrayner⁹, Aljowder¹⁰, and Santos-Neto². Unfortunately, their descriptions were relatively normative. Evaluation, validation, and verification (E/V/V) should be mandatory phases in MM creation. MM should obtain recognition from academic and practical views before its deployment. Lack of reliability and feasibility will lead to failure of MMs.

To solve theoretical gap, this study performed Systematic Literature Review (SLR) on MM in digital business. It criticised MM creation processes as performed in feasible articles. It produces learning lessons as the baseline to increase the reliability and feasibility of MM. Therefore, research on MM in digital business domain can be more qualified and accepted.

This article was composed as follows. Section 2 describes how SLR was run while Section 3 unveiled results and interpretation. Then, Section 4 delivered implications and discussions. Finally, Section 5 and 6 portrayed conclusions and recommendations, respectively.

2. METHOD

This study performed meta-review analysis through SLR technique by elaborating qualified literatures on MM. It adapted SLR phases as introduced by Kitchenham et.al¹¹ that guide from criteria interpretation into systematic selection. It comprised five phases: research question postulate; data sources and searching strategies; inclusion-exclusion criteria development; quality assessment; and data extraction¹¹ (Fig. 1).

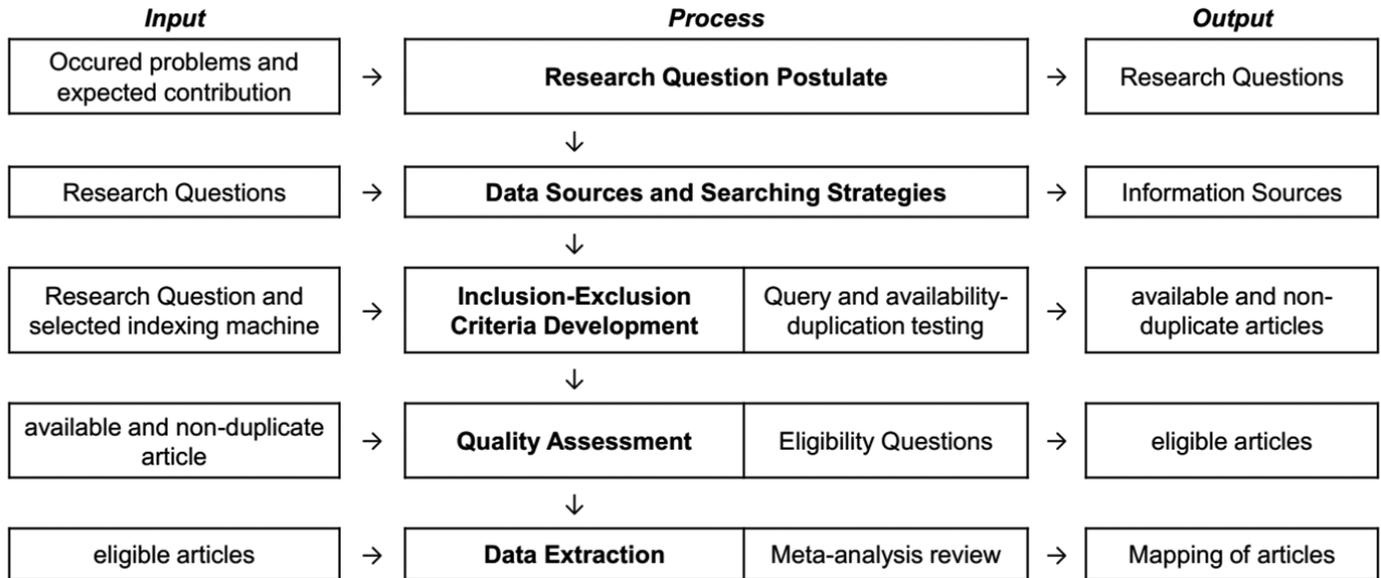


Figure 1. Research phases.

Table 1. Inclusion-exclusion criteria

Criteria	Inclusion Side	Exclusion Side
Publication status	Article is in published status	Article is under review or upcoming
Document type	Article is a journal article or conference proceeding	Article is an academic thesis, conference keynote speaker’s paper, or bibliography
Field	Article covers areas related on digital business	Article includes areas that have no relationship with digital business
Keywords	Title should contain “maturity model” and these terminologies: “develop“, “toward“, “build“, “design“ or “proposal	Title did not contain “maturity model” and these terminologies: “develop“, “toward“, “build“, “design“, or “proposal
Period	Article was published between 2001 until 2019	Article published before 2001 or will be published in 2020 or more
Language	Article is written in English	Article is written in non-English

Table 2. Recapitulation of selection processes

Publisher	Initial	Screened	Eligible
ACM	5	4	1
ASCE	3	2	1
Elsevier	15	9	4
Emerald Insight	7	6	4
IEEE	27	18	5
Inderscience	4	4	1
Springer	20	13	7
Taylor and Francais	3	3	1
Other	25	17	4
unable-accessed	70	0	0
Total	179	76	28

Using meta-analysis on selected articles, this study interpreted pattern among them into insightful implication. It was classified as desk research with deduction and cross-sectional approaches refer to Saunders et.al’s taxonomy¹².

2.1. Research Question Postulate

Research questions (RQ) crystalised the problems and became determinant to ensure study’s conformity. Hence, alignment among RQs, aims, and results is mandatory. By consolidating problems as declared in Introduction, this study postulated RQs as follows:

- [RQ.01] How wide the implementation of MM in digital business area?
- [RQ.02] What are recommended attributes of research method to construct MM by evaluating the elements/components?

2.2 Data Sources and Searching Strategies

For searching optimisation, this study leveraged Scopus that aggregates many reputable and trustable publishers in scientific domains. Most of articles published by IEEE, Emerald Insight, Springer, and ACM have been indexed by Scopus. Therefore, Scopus utilisation can perform more effective and efficient searching scheme.

Table 3. The eligible articles

First Author	MM Name
Alexander ¹⁴	Nursing Home IT MM
Asdecker ¹⁵	Delivery Process MM 4.0
Boughzala ¹⁶	Community MM
Boughzala ¹⁷	Collaboration MM
Cuylen ¹⁸	e-Invoice Process MM
De Soria ¹⁹	Enterprise Collaboration MM
Domingues ²⁰	Integrated Management Systems MM
Eckert ²¹	Inner Source Implementation MM
Gandhi ²²	MM for Gig Economy Business Process
Gaur ²³	Internet of Things MM
Jairak ²⁴	Trust Capability MM
Jin ²⁵	Health 2.0 MM
Lahrman ²⁶	New Service Development MM
Liang ²⁷	Business Intelligence MM
Marx ²⁸	Multifunction BIM MM
Mollasalehi ²⁹	Management Control Systems MM
Nawrocki ³⁰	Integrated BIM and Lean MM
Neff ³¹	eXtreme Programming MM
Pour ³²	MM for Service Systems
Proença ³³	Information Governance MM
Rapaccini ³⁴	MM for New Service Development
Rios ³⁵	MDD MM
Salah ³⁶	MM for AUCDI
Stojanov ³⁷	Scaling Agile Framework MM
Valdés ³⁸	e-Government MM
Vaz ³⁹	Intellectual Capital MM
Wendler ⁴⁰	Organizational Agility MM
Willner ⁴¹	MM for ETO Production

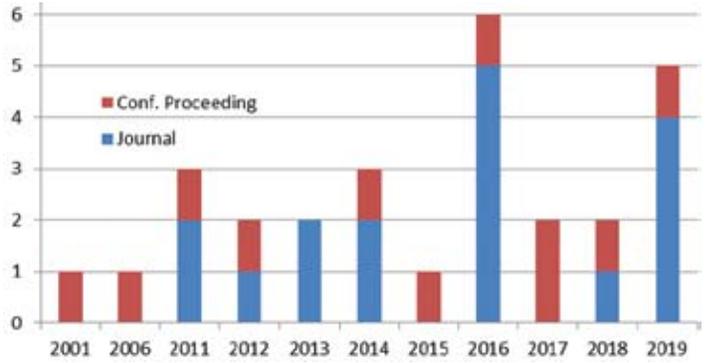


Figure 3. Annual published articles distribution.

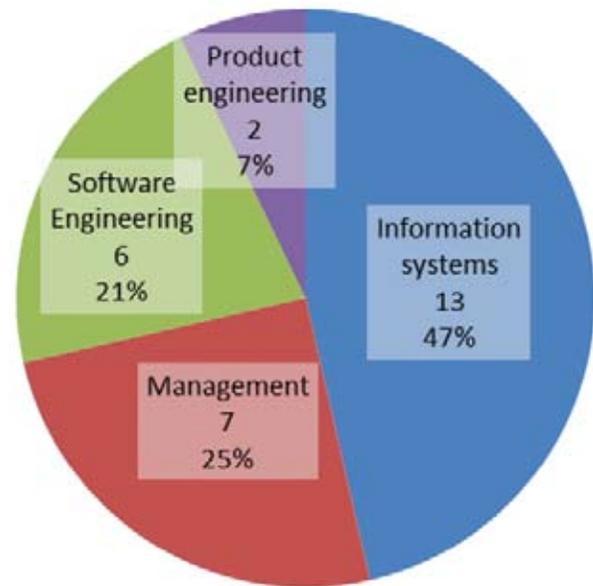


Figure 4. Mapping for topics.

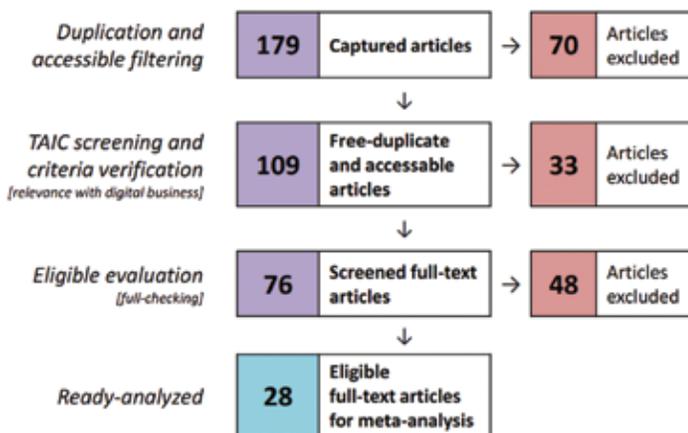


Figure 2. Summary of numerical results.

2.3 Inclusion-Exclusion Criteria Development

Inclusion-exclusion criteria expressed researchers’ aim into explicit instruction in searching process. It helps indexing machine to determine which articles met general requirements automatically, as mentioned in Pautasso’s rule¹³. Those inclusion-exclusion criteria were performed well as initial step of SLR in related studies⁷⁻¹⁰.

Since this study aimed to consolidate articles about MM creation process,—‘maturity model’ was used as main key paraphrase in a unitary quote. It also required article to include some alternatives: ‘develop’, ‘toward’, ‘build’, ‘design’, and ‘proposal’ since they reflected creation process. This study elaborated articles that published from 2001 to 2019 to accommodate trends on digital business research about two decades to keep updated as pointed by Pautasso’s rule¹³. Those criteria are declared in Table 1 and represented in Scopus query. 179 titles were captured from various sources and publishers. By using duplication and accessibility testing, 70 articles were eliminated.

2.4 Quality Assessment

109 remaining articles had been appraised using TAIC

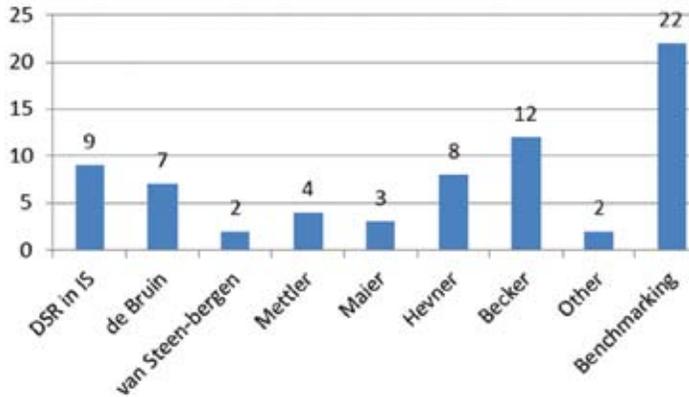


Figure 5. Mapping for referred methodologies.

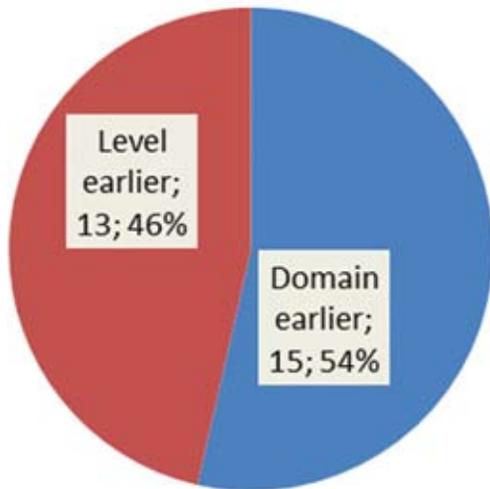


Figure 6. Mapping for cascading scheme.

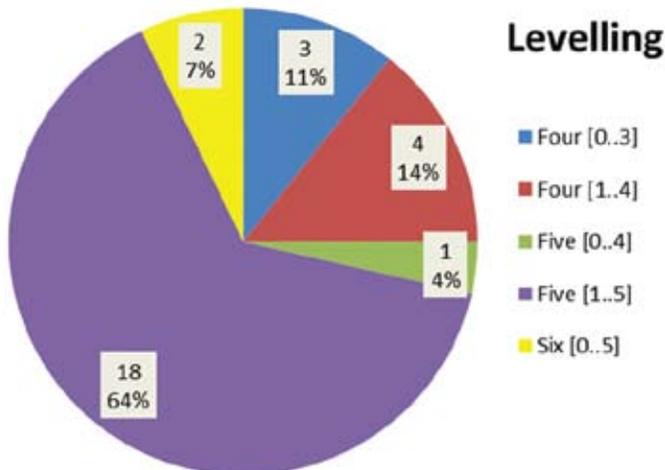


Figure 7. Mapping for leveling.

(Title, Abstract, Introduction, and Conclusion) screening and content evaluation. TAIC screening examined parts of a full-text article to judge the strength of relationship between articles and criteria as set in Table 1. 76 articles were continued after this screening. Full-manuscripts were examined using these

questions for content evaluation:

- [EQ1] Does the article exactly describe research methodology?
- [EQ2] Does the article unveil definition and instruments/criteria for each maturity level?
- [EQ3] Has the MM tested/validated/verified as quality control?

All questions should be responded by ‘yes’. 28 articles were eligible and processed into meta-analysis review in further phase. Table 2 reveals recapitulation of articles refers to publisher for entire phases, while Table 3 enlists first author’s last name and MM name. As summary, selection processes are portrayed in Fig. 2.

2.5 Data Coding and Analysis

This phase run two primary classifications: width of MM implementation and research method attributes on MM creation. Reflecting RQ.01, first primary classification unveils general categories on eligible articles related on topic, publishing information, and document type. The second one covered any information related on used methods in MM creation, such as types of maturity status, how to construct domain, how to classify variables, and validation methods to answer RQ.02.

3. RESULTS AND ANALYSIS

3.1 Width of Implementation

This sub-section examined the general characteristics of articles depend on document type, published year, and taken domain. Those criteria reflected the width of implementation as required by RQ.01. Out of 28 articles, this study identified 17 journals (60.71%) and 11 conference proceedings (39.29%). Journal’s domination signalled that complete research on MM creation spent much space. This study argued that more space was required to covers many artifacts and description, such as existing MMs comparison, level definition, instrument for measurement, and classification scheme.

As shown in Fig. 3, MM has coherence with digital business trends. MM was believed as solution to standardise technology adoption depend on trending usage, such as Extreme Programming in the beginning of 2000’s³⁰, e-Government in the beginning of 2010’s³⁸, Agile Programming in the middle of 2010’s³¹, and Industry 4.0 in the end of 2010’s¹⁵. It showed that maturity is feasible to fill academic gap in responding to practical issues on digital business. By mapping the articles into topics related with digital business, this study revealed four categories: IS, Management, Software Engineering, and Product Engineering (Fig. 4).

3.2 Research Method Attributes in MMs

This subsection shows any findings related with attributes of MM creation. Numerical statistical were embedded to strengthen the argumentation to solve RQ.02. To enhance the argumentation quality, this study examined the effectiveness of each attribute to the research impact.

3.2.1 Referred Methodologies

All articles were classified to the referred methodologies

(Fig. 5). This categorisation was important to show basic thinking that can be adopted for MM development. Moreover, it also disclosed whether the methodologies can be combined to generate feasible MM. Generally, benchmarking was most likely method due to its flexibility and simplicity in improving the existing MM.

This study found that design science research in IS⁴² introduced by Hevner et.al could be used as the baseline. This study also identified methodologies from Becker et.al⁵ and de Bruin et.al⁴³ as popular methodologies. Although different terminologies and steps were used, in principle, they stated Problem Understanding as the initial step. It means the researcher should confirm any practical or theoretical gap as part of the research motivation. Researcher should also emphasise the importance of understanding the MM users. Finally, testing is a mandatory process to prove the feasibility and reliability of MM.

3.2.2 Hierarchical Type

When a MM was created, it elaborated several instruments as reflection of level achievement. Between level and instrument, MM has focus areas; sometimes called as ‘dimension’, ‘domain’, or ‘topic’; as a group of instrument with certain similarity. Some MMs set focus areas into relevant level since each focus area represented the practice of certain level. Called as staged hierarchy, this type instructs the researchers to classify the domain or area into relevant level. It affects more activities and argumentations to strengthen the classification. On the other hand, some MMs constituted all focus area to cover all maturity level. Called as parallel hierarchical type, it mandated each focus area to has own definition for each level.

Most of articles follow parallel hierarchical type (19 articles or 68%). It was more than staged type with nine articles only. Generally, this study suggested MM creation processes to formulate definition on each level and each category/domain in early phase. By using MM creation processes as formulated definition; researcher can decide hierarchical type of the MM.

3.2.3 Maturity Status

Related with the maturity status measurement, this study distinguished two main classes: unitary and multi-results maturity status. Both of them showed the mechanism to determine the maturity status, whether each domain should be tested separately or synthesised directly. Unitary maturity status refers to concept where all instruments are measured directly as a single result without any decomposition. Due to its simple calculation, it is more suitable for MMs with less complexity, such as Health 2.0 MM³². On the other side, multi-results instruct more detail calculation since each domain or categories need to be measured separately. As an example, Valdes et.al introduced e-Government MM⁴⁷ using multi-results maturity status with more detail landscape. It is more rigid than unitary since it mandates measurement on each category. However multi-results maturity status reveals more detail and specific landscape that helps user get more interpretation.

3.2.4 Cascading Scheme

This part attempted to understand which one earlier

definition between the level and domain (Fig. 6). Although most of articles defined the domain earlier, its proportion was not too dominant. Moreover, none pattern is identified among them with other categorisation, such as methodologies and type of hierarchy. It signals that cascading scheme may become the researcher’s authority to determine it.

3.2.5 Leveling

This study reviewed how MMs arrange level and its definition. All of them define first/lowest level as ‘nothing applied practice’ while the second is defined as ‘applied practice without quality’. Finally, the highest level reflected the most qualified and complete practices. Five levels with scale 1 to 5 dominated the distribution with 18 articles, such as Alexandre et.al¹⁴, Jin et.al²⁵, and Rios et.al⁴³. Moreover, five levels concept was also adopted by Cuylen¹⁸ using scale 0 to 4. This phenomenon was occurred since most of them conducted literature review on related existing MMs. Those related existing MMs has been dominated by five levels. Therefore, this domination has been followed with general gradation. Interestingly, four levels as performed by eXtreme Programming MM³¹ had fewer followers. Generally, five levels allowed the researchers to adjust the gradation among three remaining level in the middle smoothly. Figure 7 displays domination of five levels.

3.2.6 Sources of Criteria

This study also mapped the sources of criteria that had

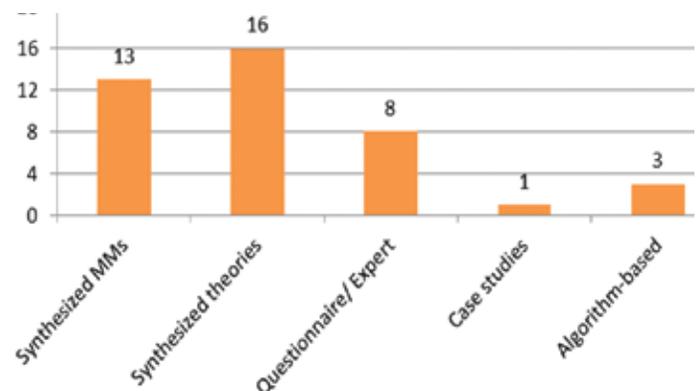


Figure 8. Mapping for criteria sources.

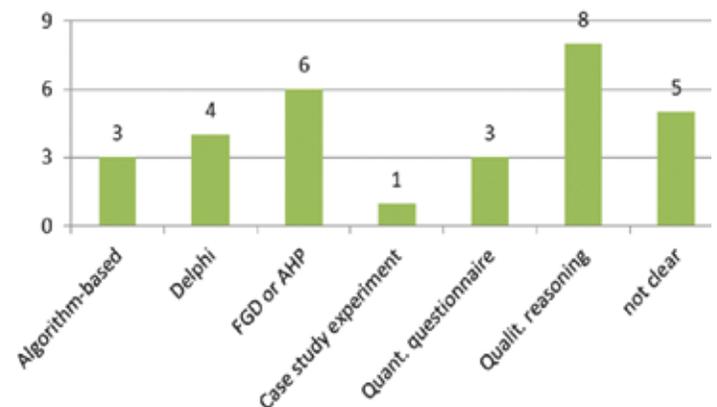


Figure 9. Mapping for classification schemes.

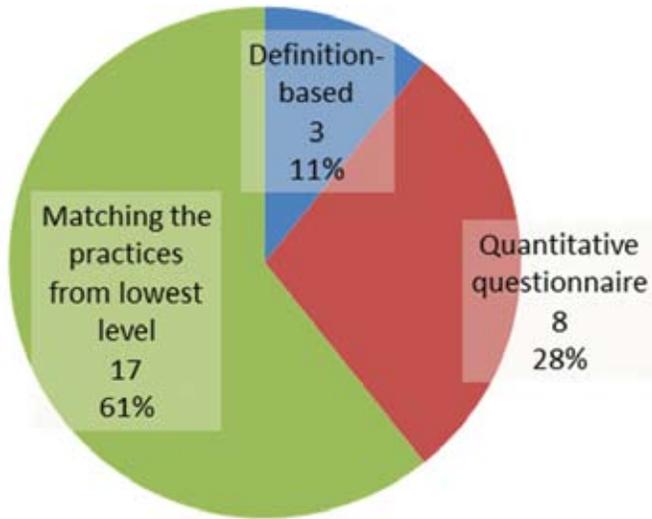


Figure 10. Mapping for implementation technique.

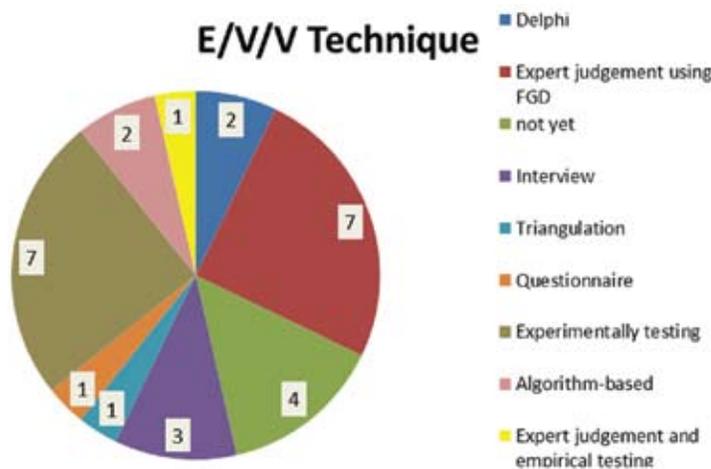


Figure 11. Mapping for E/V/V technique.

been elaborated as core of MM (Fig. 8). There were three common sources in this attribute. First source was theories that strongly related with MM. They were synthesised using various schemes, such as exploring definition, critical success factors identification, determinant factors identification, and mathematic model adoption. It is suitable and feasible for MM which is relatively new. As for the second one, researchers had another alternative, i.e. synthesizing the existing MMs that had similarity and relevance. This scheme is more recommended if MM aimed to upgrade the previous MMs. However, many articles decided to adopt both them to get stronger and more qualified MM and sharpen the novelty. The third one, questionnaire or expert opinion can be considered as scheme to generate sources.

3.2.7 Classification Scheme

This part portrayed how the articles formulate which criteria should be allocated in the certain level (Fig. 9). It related strongly with how researchers adjusted gradation among levels inside the MMs. 23 had declared clearly what are the classification scheme that adopted. Most of them relied on qualitative reasoning to classify variable into relevant

level, especially researcher’s interpretation. This scheme had weakness since it was rather subjective, moreover if no expert was involved. As an impact, classification with qualitative reasoning required qualified E/V/V to ensure its reliability and trust. Hence, qualitative reasoning should leverage expert judgments to absorb more objective and qualified thinking and experience.

Although quantitative questionnaire, algorithm-based, Delphi, and AHP had been adopted by fewer articles separately; aggregated data among them would dominate classification scheme as quantitative approach. It indicated that most MMs chosen objective classification using certain formula. This approach can reduce doubt and ambiguity.

3.2.8 Implementation Technique

This study examined the attribute of implementation technique. Three basic techniques were used: Matching the practices from lowest level, Definition-based, and Quantitative questionnaire (Fig. 10). Definition-based is the simplest technique, but it can carry on bias interpretation. Therefore, it is not suggested for MMs with complex ecosystems. Quantitative questionnaire can prevent ambiguity using exact calculation, but it spends more time to validate the formula. Matching the practices from lowest level is relatively simple, but it requires strong argumentation. It offers win-win solution for the users where they can leverage the practices generated on each level as argumentation to determine whether a level has been complied. Generally, both of Definition-based and Matching the practices from lowest level should be supported by evidence to strengthen the argumentation and compliance. Researchers should minimise doubt by mandate clear differentiation among practices across the levels. Evidence-based is recommended to ensure its compliance and feasibility.

3.2.9 Evaluation/Verification/Validation Technique

This study found that most of MMs had been tested using any E/V/V. This adoption signalled reliability since researchers have proven the MM empirically. This distribution was also dominated by qualitative approach (Fig. 11). Ideally, an idea should be tested before deployment. Moreover, testing using E/V/V techniques is an iterative scheme through repetition until fulfilling requirements. Several iterations have been practiced and declared by some articles, such as Nursing Home IT MM¹⁴. Iteration scheme showed that researchers should prepare enough time to anticipate if first iteration was not satisfied enough.

Generally, the most used techniques were experimentally testing and expert judgments using FGD. Experimentally testing meant the researchers put the MM into real organisations and allow them to do self-measurement. During the measurement process, researchers examine feasibility qualitatively to identify whether any inappropriate instruments and related feedbacks. However, this technique mandates the researchers to have strong access to organisation. Hence, articles that performed it adopted the purposive sampling in few organisations. However, this technique enables strong recognition since it has been empirically proven. Expert judgments using FGD was held by inviting people with strong expertise on related domain

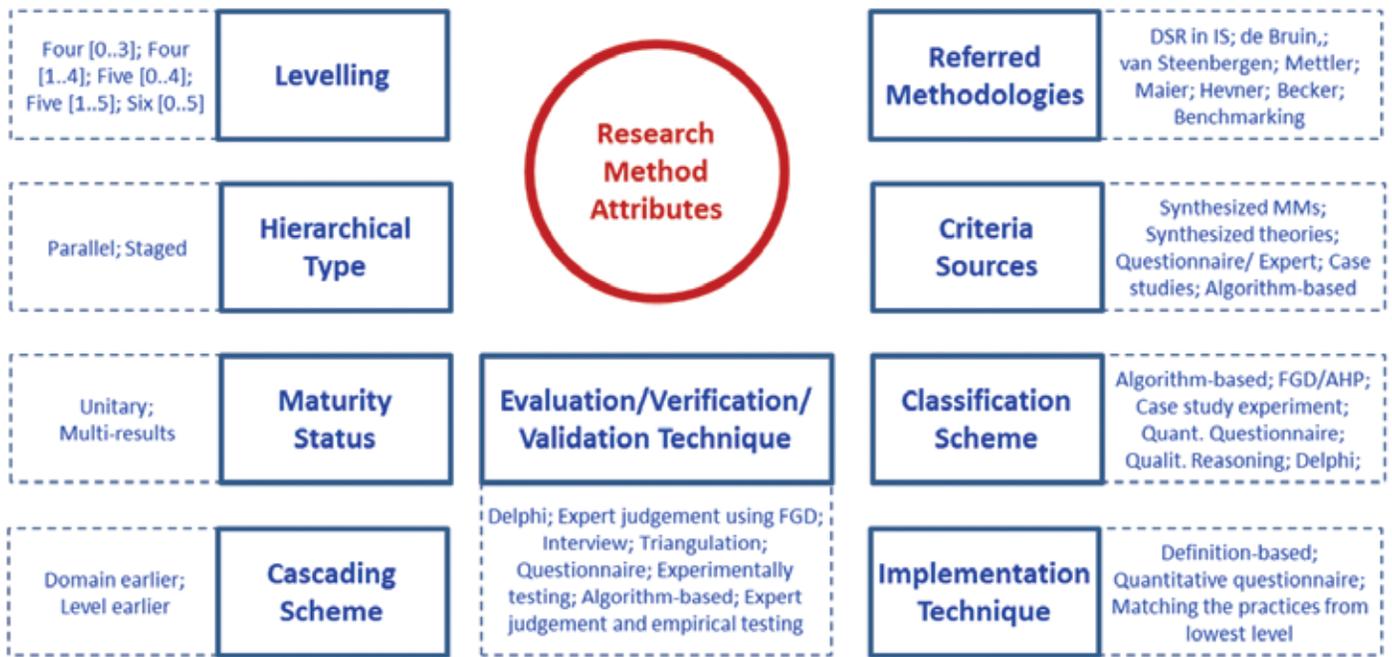


Figure 12. Taxonomy map of all research method attributes.

to expose feedback in synchronous meeting. This technique allows researchers involve many experts. It also enables more various backgrounds to make it more representative. Interestingly, Willner et.al mixed both of them as sequential techniques⁴¹. Although more time and resources are spent, the result would be more qualified.

4. DISCUSSION AND IMPLICATION

After explore the width of implementation of MM on digital business, this study suggests further research to publish MM creation processes in journals. Most of journals accommodate more pages so that its narration and artifacts can be included. This chance enables the readers to get more comprehensive understanding. Moreover, they can use the instruments directly in real world-based organisation. Hence, the articles can be cited and followed by other researchers and organisations. In fact, 17 journal-based articles had been cited 288 times (average 16.94) while 11 conference proceeding-based articles cited 188 times (average 10.73).

Related with RQ.02, this study decomposed the research method attributes into nine categories. This decomposition promotes some techniques and schemes to be articulated in further research methods. Researchers can elect several alternative methodologies as introduced by de Hevner et.al⁴², Bruin et.al⁴³, and Becker^{5, 6}. They provided relative complete sequential phases as MM creation guidelines. They mandate the researchers to analyse the user persona as philosophical foundation in the initial phase. They instruct E/V/V as a mandatory quality assurance.

Based on distribution generated in the previous section, this study documented them in a taxonomy map (Fig. 12). It comprises fields, types, schemes, and techniques as practiced by 28 elected articles. It may be improved since many schemes and techniques can be synthesised, even combined with any

new schemes and techniques. It also may be converted into recommender systems to support decision in the research method attribute selection.

5. CONCLUSION

This study has reviewed 28 selected articles to solve the crucial issues as postulated in two research questions. Width of MM implementation on digital business domain showed strong domination on IS and also journal-based. Related with research method attributes, this study has mapped the selected articles into nine attributes: referred methodologies, hierarchical type, maturity status, cascading scheme, leveling, criteria sources, classification scheme, implementation technique, and E/V/V technique. They generated more comprehensive explanation about alternatives that can be picked by researchers to create or improve MMs with more complete phases. Looking at previous experience, experimentally testing and expert judgments using FGD were most-likely proven techniques. Deciding which one is proper should consider the availability of resources, time, and access. This finding solved lack of validation as occurred in research on MM. Moreover, this study provided argumentation and rationalisation to that the MM can be more accepted and adopted in real world.

6. FUTURE OUTLOOK

This study believed that information sources can determine the information quality. Therefore, it suggested the expansion of sources by including the reputable Q1 and Q2 journals. This study also suggested more variety mapping with deeper analysis, such as performance comparisons. It can reveal effectiveness and efficiency. Hence, researchers can decide proper technique considering domain, aim, available resources, and time.

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CONTRIBUTORS

Arfive Gandhi is currently pursuing Ph.D. degree in Faculty of Computer Science, Universitas Indonesia. His current research interests are digital business, information security, e-government, e-learning, and user experience. Since 2018, he has managed a research team to explore gig economy as trending phenomenon in Indonesian.

Yudho Giri Sucahyo is currently a professor on e-government in Faculty of Computer Science, Universitas Indonesia. He received his Ph.D. degree from Curtin University. His current research interests also include information security, digital business, IT governance/risk/compliance, and data mining.