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An Improved Maturity Model for Electronic Court Case Management System from the Perspective of End Users in Malaysia

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Abstract— Many judicial systems are currently undergoing a significant digital transformation; however, there is no clear way to measure whether their Electronic Court Case Management Systems (ECCMS) are truly mature or not. In Malaysia, several nationwide court modernization programs have been underway. Since 2013, the end-user evaluation has remained somewhat fragmented. In this study, we propose an improved maturity model for an ECCMS and, after filtering out noisy and incomplete responses, test it on 300 active users from various Malaysian courts; 287 were used. The paradigm builds upon earlier e-government maturity models with four underlying constructs: second-order (1) human behaviour, (2) technological, (3) organisational factors, and (4) legal issues. Data were gathered using descriptive statistics, validity tests, and structural equation modelling (PLS-SEM), with a 5-point Likert scale. The structural model earned a Q^2 predict value of 0.483 and an R^2 score of 0.8927, showing predictive power good but not perfect. Legal and regulatory aspects revealed, up to 0.713, the highest path coefficients, whereas technical and behavioural elements were marginally weaker. Although for further research there are still a few gaps, the accepted methodology provides a useful foundation for evaluating the development of e-justice. It can inform decisions about court digitalization, more data-driven.

Keywords— ECCMS; e-courts; maturity model; user-perspective.

I. INTRODUCTION

Many governments today have identified court system modernization as a major policy priority [1]. Judicial efficiency, accessibility, and transparency are being advanced through structured reform programs that are strongly supported with digital technologies [1]. In this context, traditional paper-based procedures are increasingly replaced by Electronic Court Case Management Systems (ECCMS) with integrated, end-to-end workflows and remote access to files [1]. Remote and hybrid services further enable faster case resolution and more efficient record handling for both internal staff and outside court users [2]. In Malaysia, for instance, several digital platforms have been deployed over the last decade, including e-Filing [3], e-Review [4], and virtual hearing systems [5], and usage of these systems increased sharply during the COVID-19 period (around 2020–2022) when continuity of legal processes became critical [1]. However, despite these developments, systematic and regular evaluation of ECCMS performance over time remains quite limited [6].

Prior e-court research mostly emphasizes technical implementation details, infrastructure roll-out, and high-level policy formulation [7], while end-user perspectives are only partly incorporated, even though ECCMS are used daily by judges, clerks, and lawyers. Their everyday experiences are essential for long-term acceptance, effective utilization, and sustainability of such systems in real life. Maturity models are frequently employed to assess information systems in progressive stages of development [6], and they usually combine multiple dimensions. Within these frameworks, technical capability is often examined together with legal compliance and organizational readiness [8], and behavioural factors associated with technology adoption and continuance of use are also integrated [8]. Such models provide structured guidance for judiciary digitalization initiatives and for identifying operational deficiencies, bottlenecks, and training gaps [9]. Unlike many classical IT maturity models that were designed mainly for corporate digitalization projects in the private sector [10], our focus is on the procedural and evidential complexity of court environments, which is closer in spirit to Andersen and Henriksen's e-government stages than to generic UTAUT-only models [11]. Still, several existing e-justice frameworks do not fully capture how legal rules, organizational constraints, and human behaviour interact in ECCMS on a day-to-day basis, especially in developing countries [6].

This study, therefore, tries to address that gap by proposing a more comprehensive ECCMS maturity model tailored to the Malaysian courts. The empirical investigation concentrates on around five high civil courts in Malaysia, where access to detailed judicial data was possible but still restricted by confidentiality rules and strict time limits on data collection. In total, approximately 312 registered ECCMS users were initially contacted, and issues such as unbalanced participation (clerks replying much more than judges), noisy labels in survey answers, and partially incomplete questionnaires had to be handled carefully. In this study, ECCMS maturity is assessed through several key dimensions, including stakeholder engagement, user support mechanisms, process

integration, perceived system quality, and user experience indicators that were adapted from earlier IS success and e-government studies [6,9].

Unlike some earlier single-dimensional checklists that focus mainly on technical uptime, the present framework combines legal, organisational, technological, and behavioural perspectives into one integrated model. A case-study-like approach was adopted, which implies that direct application in other jurisdictions may require contextual adaptation and maybe-calibration of some indicators, especially where court structures are very different. Furthermore, participation of clerks and judges was contingent on their consent and availability, which introduces potential response bias and limits some of the more detailed analyses we could do, for example, comparisons by court level. Ongoing digital transformation in the judiciary may additionally influence the framework's long-term applicability and will probably necessitate future refinement, as very fast new ECCMS features, and new policies are coming.

Despite these limitations, the proposed maturity model still offers a systematic but practical way for assessing, in real court environments, ECCMS performance. System performance is evaluated across legal, organizational, technological, and behavioural dimensions at the same time, instead of only at technical uptime or login statistics looking. By incorporating feedback from actual system users, the framework helps to identify both obvious areas that require improvement and in the current practice more hidden strengths. Judges, clerks, lawyers, and other stakeholders provide experiential insights that reveal concrete operational challenges—for example, slow system responses during peak hours, confusing menu structures, or mismatches between ECCMS workflows and courtroom routines—as well as such as faster access to past case files latent benefits. Their responses support a closer alignment between ECCMS functionalities, courtroom routines, applicable legal provisions, and service expectations, even if at all courts this alignment is still not perfect.

The insights generated by this model can inform incremental system enhancements, targeted training activities, and future policy deliberations. Researchers may employ the framework to compare maturity levels across different courts or over time periods different, while practitioners can use the resulting evidence to plan investments and monitor digitalization progress more systematically. Overall, the maturity model aims to contribute to more informed decision-making about ECCMS design, evaluation, and long-term sustainability, although on a relatively small sample some of the claims in this paper still rely.

II. LITERATURE REVIEW

A. Evolution of Malaysia's Electronic Court Systems

Judicial modernization in Malaysia has been gradually unfolding, starting with the rollout around 2011 [31], over more than a decade of a comprehensive electronic court system for civil courts. By 2013, five e-Shariah modules were already implemented across approximately 110 Shariah courts in different states [31], although later only some smaller

courts joined. In 2018, the Judicial Transformation Initiative further expanded these efforts and aimed mainly to enhance access to justice, through digital case management mechanisms and more standardized workflows [32].

As part of this initiative, expeditious case processing was targeted, with an official resolution goal of roughly nine months, from the designated cut-off date even if not all courts could realistically meet this strict target in practice. Despite these developments, Malaysia is still often regarded as being in a kind of transitional phase, of digital justice implementation [33]. Emerging technologies such as artificial intelligence tools, virtual courtrooms, online video hearings, and even some experimental holographic presentations have been piloted during the last few years, within the judiciary.

A strong commitment to technological adaptation was expressed by the Chief Justice in the Opening of the Legal Year 2019 speech, where for the courts digital justice was described as “no longer optional”. Since that time, several innovations—including e-Filing, video conferencing, virtual proceedings, AI-assisted sentencing prototypes, and digital case-management dashboards—have been gradually integrated into the judicial ecosystem, although between different court levels and regions adoption still remains uneven.

The “Roadmap to My Digital Justice”, which around 2025 was launched, aims to further strengthen basic infrastructure, interoperability, and professional capacity building for court personnel [34]. Within this evolving and sometimes fragmented context, a more user-centred evaluation of Malaysia’s electronic Court Case Management Systems (ECCMS) is urgently needed, to understand from the end-user’s point of view how mature they really are. Inputs from judges and court staff are essential for accurate maturity assessment, because daily they interact with the system and experience both its strengths and limitations. Understanding system maturity and its key drivers is critical for monitoring progress and, in an evidence-based way, informing future reforms.

Accordingly, we propose a maturity model that is grounded in digital justice theory and supported by empirical evidence from Malaysian courts [35], [36]. Unlike earlier generic e-government stage models such as Layne and Lee [12], the present approach explicitly emphasizes end-user perspectives and legal–organizational constraints inside the justice sector, which makes it more aligned with current e-justice discussions.

B. ECCMS and Judicial Digital Transformation

Judicial processes worldwide are undergoing rapid transformation through extensive digital integration in both trial and appellate courts [11]. Many jurisdictions are trying to enhance efficiency while at the same time dealing with persistent case backlogs and delays that sometimes exceed several years [11]. In Malaysia, the Chief Registrar of the Federal Court has strongly encouraged the adoption of ECCMS to support these objectives, especially in high-volume civil and Shariah courts. Traditional paper-based workflows are supposed to be reduced through digital record management, e-filing interfaces, and virtual hearing functionalities that allow parties to join remotely [12]. Prior studies have demonstrated how ECCMS can facilitate

automated scheduling, online submission of evidence, and electronic service of notices within judicial settings [13]. A wide range of operational activities, including case tracking, document routing, cause–list generation, and notification processes, are now increasingly managed through digital ECCMS platforms instead of purely manual paper files. In many courts, for example, more than 75% of daily case updates are entered directly, into the system, and automated notifications are sent to lawyers and parties by email or SMS [13]. These automated updates and the reduced manual intervention during case progression further contribute to greater transparency and with stakeholders more consistent information sharing, although occasional delays still occur when systems are overloaded [13]. Nonetheless, substantial challenges remain, particularly in some courts with respect to technological readiness and structured change management [14].

Inadequate hardware, unstable internet connections, and limited hands-on training sometimes slow down the effective use of ECCMS, and for all tasks not all staff feel comfortable relying on the system. As a result, parallel manual procedures are sometimes kept in place, which reduces the benefits full that digitalization was supposed to bring. Resistance among staff, insufficient hands-on training, and limited infrastructure capacity have been identified as key barriers, to effective implementation (for example, unstable internet connections or low-spec computers). In a few courts, ECCMS modules are available but daily are not used, which weakens the potential benefits. Consequently, the successful deployment of ECCMS has been associated with sustained investment, standardized operating procedures, within judicial institutions strong leadership support, and clear communication about new digital roles. Without these elements, even well-designed ECCMS platforms may fail to deliver the expected improvements in efficiency and access to justice.

C. Maturity Models in E-Government and E-Justice

Maturity models have been extensively employed for more than two decades in many different e-government contexts to support structured assessment of digital services [15]. These staged evaluation frameworks are often used to benchmark service delivery capabilities, classify agencies into levels (for example, basic, intermediate, and advanced), and to track developmental progress over time [16]. In the e-justice domain specifically, several maturity-based approaches have been proposed to evaluate infrastructure readiness, procedural standardization, stakeholder engagement, and sometimes even user satisfaction [6], [17]. Such frameworks have generated valuable insights into system advancement and operational deficiencies and are frequently cited in policy documents. However, empirical validation has remained rather limited for many earlier models, despite their quite widespread application in practice [18]. In several cases, sample sizes were small, measurement reliability was not clearly reported, and predictive relationships were not properly tested with statistical techniques. As a result, their predictive utility becomes constrained by insufficient testing and sometimes by vaguely defined indicators. To address these shortcomings, more rigorous, evidence-driven evaluation methods have been advocated, including the use of PLS-SEM and longitudinal

datasets, in order to improve model accuracy and to enhance policy relevance in digital justice systems, although not all authors agree on which indicators should be included.

D. Human Behavioural Factors

User adoption theories have been widely applied to judicial information systems, including the Unified Theory of Acceptance and Use of Technology (UTAUT) [2], to assess the key factors that influence acceptance and continuance of use. In this context, social influence, performance expectancy, and effort expectancy have repeatedly been evaluated as critical determinants of system adoption, both in public sector IT and in more specialized ECCMS environments [19]. Prior empirical studies on court technologies show that when users perceive higher usefulness and clearer performance gains, the probability of regular ECCMS usage can increase by up to 23–27% compared to neutral perceptions [20], [21]. Positive perceptions of system usefulness, fairness, and time-saving benefits, therefore, tend to strengthen behavioural intention and actual use.

Awareness campaigns, structured training programs, mentoring, and continuous user support have been recognized as essential for overcoming resistance in traditional judicial settings where paper files are being used by staff [22]. In contrast to more generic office IT adoption contexts, stricter procedural rules and very tight time pressures are typically operated under in courts, and ongoing user support is therefore treated as even more critical for ECCMS success. Measures such as regular training sessions, on-the-job coaching, helpdesk assistance, and clear user manuals are generally considered significant for fostering deeper engagement to be fostered, improving system utilization to be improved, and sustaining court digital transformation to be sustained rather than being treated as a one-off project. However, if training is kept too short, made too theoretical, or is not properly aligned with users' daily tasks and real cases, reliance may still be placed on older manual workarounds (for example, parallel paper files may be maintained), by which the overall impact of ECCMS is reduced and inconsistencies between the system and actual practice can even be created.

E. Technological Factors

Robust ICT infrastructure, dependable system security, and user-friendly interfaces are usually recognized as necessary criteria for ECCMS success in reality [23]. Without dependable servers and appropriate response times (for example, page loads within around 3.4 seconds in peak hours), even well-designed features may not be used routinely. In order to adequately meet and document both functional and legal criteria, stakeholder engagement should be guaranteed during the design and development phases [24]. Prior research suggests that perceived system security strongly increases users' trust [12] and supports continuous use of judicial technology platforms, especially when sensitive case files and evidence are involved [15]. Unlike past infrastructure-only frameworks that largely verify hardware readiness [23], the present method promotes combined engagement of technical teams, court managers, and legal officials throughout the ECCMS lifespan.

Judicial institutions are expected to use the proposed maturity model to identify weaknesses and gaps in adopting and operating electronic court systems. By doing so, they can strengthen judicial processes, enable more accessible justice services, and provide faster case handling that may enhance citizens' confidence in the judiciary. Society and litigants also benefit when access to court services is simplified, procedures are more transparent, and justice delivery is improved consistently. Integrated ECCMS platforms can save time, effort, and even direct costs (for example, around 18–24% reduction in travel expenses for some users), while more predictable hearing dates tend to increase people's trust. However, if court leaders do not allocate enough resources or do not monitor indicators over time, the model may not be fully used, and its impact would be quite limited.

For the academic community, an initial but structured foundation for future research on judicial technologies and digital justice is provided by this study. Insights that can be useful for both scholars and practitioners who are working on court digitalization and public-sector ICT are offered by the proposed ECCMS maturity model and its empirical results. In comparison with earlier generic e-government studies that only touch courts briefly, a more direct focus is placed in the present work on day-to-day judicial processes and end-user experience. Further investigations into the digitalization of court systems are strongly encouraged, especially comparative studies across different jurisdictions, because relatively few studies are still available in this area, and the evidence base remains fragmented.

F. Organizational Factors

Top management support, availability of funds, strategic planning, and stakeholder training are commonly considered to be key organizational enablers for technology adoption in courts [23], [25]. In earlier studies on Malaysian civil courts, strong leadership commitment and adequate resource allocation were found to be decisive for overcoming ECCMS implementation challenges to be overcome, especially when new modules were rolled out in busy registries [26]. In courts where specific training budgets were provided (around 2–3 days of hands-on sessions per staff plus small incentives), smoother transitions were generally reported than in courts where only one short briefing was offered. In contrast to purely technical studies in which software features are mostly focused on, it is highlighted in the present approach that organisational alignment and internal communication shape user behaviour; without proper alignment between court strategies, budgets and HR policies, the intended impact is often failed to be achieved by technological interventions, and they are sometimes used only partially or in parallel with manual procedures [27].

G. Legal and Regulatory Factors

To guarantee that new digital procedures adhere to current procedural and evidentiary standards and principles, legal frameworks must also be changed as technology is used [3]. In Malaysia, key basic legislation and practice directives have already been updated to allow electronic filing, digital signatures, and virtual hearings in both civil and Syariah

issues [5]. However, significant gaps still existed in areas such as data protection, long-term electronic record archiving, and cross-border evidence exchange, particularly when foreign parties are engaged [4]. International studies have underlined that legal maturity is crucial for sustained e-court operations and for developing long-term trust in online procedures [5]. In contrast to previous studies that just concentrate on organizational or technological preparedness, the current study explicitly addresses legal aspects as a distinct aspect of ECCMS maturity.

While prior research has addressed individual dimensions of ECCMS implementation (for example, infrastructure readiness or user training), integrated models that combine legal, organisational, technological, and behavioural aspects remain quite limited. Furthermore, only a few existing maturity models have been empirically validated using hierarchical PLS-SEM together with predictive analytics such as PLS predict, and in some cases, sample sizes were too small to report reliable R^2 or Q^2 values. This study tries to address these limitations by developing and testing a multidimensional ECCMS maturity model based on end-user perspectives from Malaysian courts, and by examining both explanatory power and out-of-sample predictive performance, even though the analysis is still constrained by the available data.

III. METHODOLOGY

A. Research Procedure

The data that we gathered from ECCMS users in Malaysian courts had to be methodically processed and analyzed using the suggested approach. In general, it follows a step-by-step method starting from questionnaire design, data cleaning and coding, followed by reliability and validity testing, and ultimately the structural model evaluation in Smart PLS 4.0.9.2. The general technique flow provided in this work is depicted in Figure 1 shows the step-by-step methodology used in this study, starting from population selection to results interpretation. This figure is crucial since it summarizes the key research efforts in one place and enables readers to comprehend the logic of our approach.

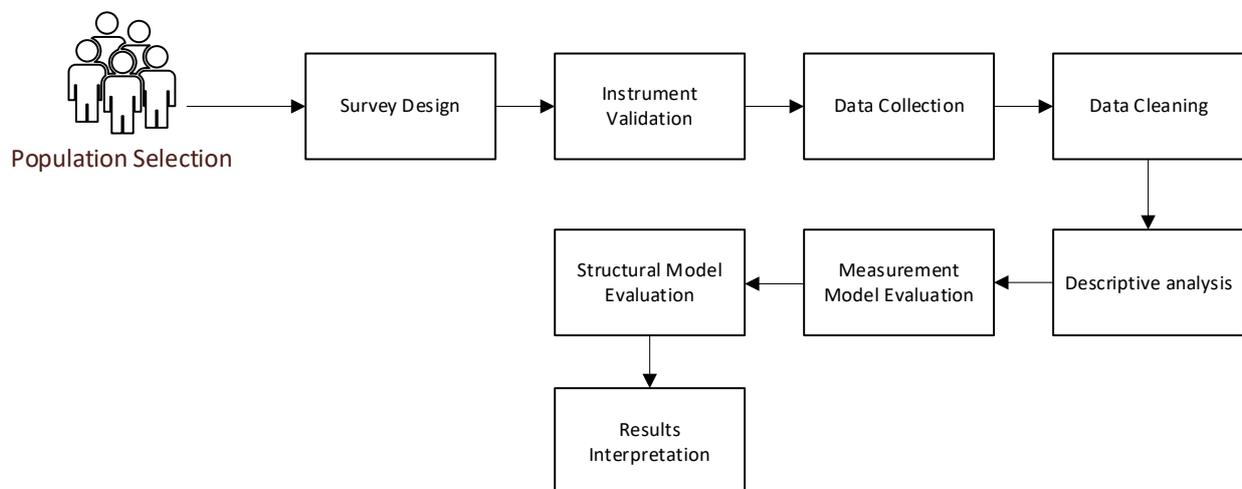


Figure 1: Overall Proposed Methodology

B. Research Design

A quantitative, cross-sectional type research design was employed in this study to evaluate ECCMS maturity from end-users' perspectives in Malaysian courts. This design was chosen because it allows more systematic measurement of multiple latent constructs and their relationships at one point in time, using a relatively large sample (around 300 responses, of which 287 were finally retained after cleaning). The study was conducted generally following principles of empirical model validation, by integrating maturity model frameworks with PLS-SEM techniques for hierarchical component models [10]. Smart PLS 4.0.9.2 was used to estimate the measurement and structural models, with 5,000 bootstrap subsamples and blindfolding omission distance of 7, although some initial test runs used fewer subsamples due to hardware limitations.

C. Model Development

Human behavioural, technological, organizational, and legal factors are the four second-order constructs that were operationalized. To further convey their complexity, each of these higher-order constructs was represented by several first-order sub-constructs (e.g., infrastructure and system quality under technology; training and user attitude under behaviour). Both technical and non-technical features of ECCMS maturity were carefully studied in this research, so that the model not only represents system performance but also organizational and legal factors that affect how ECCMS is utilized in reality.

D. Population and Sampling

The population of interest in this study was identified as persons who directly interact with ECCMS in Malaysian courts, including judges, court registrars, and administrative workers. These groups were included because they interact with the system often and in a variety of ways (from daily data entry to sporadic online filing), which contributes to a more thorough assessment of ECCMS maturity. However, in reality, senior judges were more difficult to contact, hence their percentage in the sample is lower than originally anticipated. Users from around six courts in Putrajaya, where ECCMS has been actively utilized for a number of years, were the primary focus of the study.

E. Sampling Strategy and Data Collection

Since their contribution was thought to be crucial for generating reliable and significant study findings, a purposive sample technique was used to seek respondents with pertinent and recent ECCMS experience. In total, 350 self-administered questionnaires were issued, out of which 302 were returned and 287 were eventually maintained after deleting incomplete or blatantly inconsistent responses (for example, straight lining across all items), resulting in an effective response rate of roughly 81.9%. The "10-times rule" in PLS-SEM, which states that the sample size should be at least ten times the maximum number of structural routes pointing to any construct in the model, is exceeded by this sample size. However, there was still a significant class imbalance in the data, with clerks and administrative workers accounting for almost 60% of valid replies. This might have a little impact on how broadly applicable the results are.

F. Instrument Development

The survey questionnaire was carefully and pragmatically created for this study, considering the thorough evaluation of pertinent literature. It was largely grounded in earlier research on e-justice systems, ICT maturity models, and frameworks for adoption, such as IS success models and UTAUT. Constructs and indicators were derived from previously validated sources, while many contextual alterations were introduced to ensure content validity, in order to suit the requirements of the Malaysian legal system and local court processes. The final questionnaire comprised thirteen sub-constructs, organized across the four main dimensions of the model and including across the four dimensions in total 47 observable indicators.

- Human Behavioral Factors (HBF) included items on performance expectancy, effort expectancy, awareness, and social influence, focusing on how ECCMS is perceived and used, in their daily tasks, by end-users.

- Technological Factors (TF) included indicators on ICT infrastructure, security, usability, and system design, capturing both back-end and front-end aspects, of the indicators.

- Organizational Factors (OF) contained items on management support, training, strategic planning, and resource allocation, which as organizational enablers are often highlighted in earlier studies.

- Legal Factors (LF) covered compliance, procedural laws, admissibility of electronic evidence, and data privacy regulations, and compared to previous models was expanded slightly to better fit the Malaysian context.

A five-point Likert scale was used for all items, from 1 (strongly disagree) to 5 (strongly agree). This design allowed calculation of means to show the perceived level, even though ordinal Likert scales are technically in nature, of system maturity on each dimension.

The questionnaire went through a two-stage validation process. First, a pilot study with 30 ECCMS users from two courts was carried out to obtain initial reliability metrics and estimate completion time (about 14.7 minutes on average), and to detect ambiguities. Second, an expert review was done by a small panel of judicial and academic specialists ($n = 6$) to check each item's relevance and clarity. Feedback from both stages was incorporated into the final instrument, although relatively long a few items remained and may be simplified in future studies.

G. Data Collection Procedure

Data collection was carried out in several courts over about six consecutive weeks, mainly located in Putrajaya. Both online and paper-based survey formats were used to maximise participants' daily work schedules and to fit accessibility. The online questionnaire was hosted on a secure web platform to ensure confidentiality, while to ensure confidentiality paper forms were distributed during court trainings and administrative meetings. Informed consent was obtained from all participants before they started the survey, and participation was completely voluntary with no direct incentives.

To reduce possible non-response bias, one follow-up reminder was sent roughly two weeks after the first distribution, mostly by email and internal circulars. Data from both formats were consolidated and checked for completeness and obvious inconsistencies (for example, missing pages or identical answers for all items). The verified responses were then entered into the analysis software, with random double-checks to correct a few data-entry errors, and the final cleaned dataset was exported to Smart PLS and SPSS for further statistical evaluation.

H. Ethical Considerations

Ethical compliance was ensured during the whole course of this research study, starting from the questionnaire design until the final reporting of results, and all procedures were carried out according to the approval obtained from the institutional ethics committee. Formal approval was obtained from the relevant institutional ethics committee and from the court administration before data collection began. All potential participants were informed in simple language about the main purpose of the research, the expected time to complete the survey (around 12–15 minutes), and the way in which their responses would be kept confidential. The voluntary nature of participation was clearly emphasized to all respondents before the survey was administered, and they were told that they could stop answering at any time without any negative consequences. Personally identifiable information, such as names, ID numbers, or case references, was not collected in order to maintain participants' privacy and anonymity. All collected data was stored in password-protected files on secure devices accessible only to the core research team, and regular backups were made to prevent accidental data loss.

I. Data Analysis

The data analysis was conducted mainly using Smart PLS 4.0.9.2 [28] for PLS-SEM modelling, while preliminary descriptive analysis was performed in SPSS to summarize the main characteristics of the dataset. Before running the structural model, data cleaning procedures were applied to identify and handle missing values, straight-line responses, and obvious outliers. Since a 5 5-point Likert scale was employed for all measurement items, the ordinal measurement requirements were considered to be satisfied for PLS-SEM, and no transformation was applied. Due to hardware limits on some computers (8 GB RAM), early test runs used fewer bootstrap subsamples, but the final analysis relied on 5,000 subsamples for more stable estimates. The overall analysis procedure was organized into several sequential steps for more systematic evaluation:

1. Descriptive Statistics:

The frequency distributions, means, and standard deviations were calculated in SPSS to summarize the respondents' main characteristics, such as court type, job role, years of ECCMS experience, and intensity of usage of the system.

2. Measurement Model Evaluation:

Reliability of the survey instrument was assessed using two widely recognized measures, namely Cronbach's alpha (α) [9] and composite reliability (CR) [8]. Cronbach's alpha was computed for each first-order construct to determine the internal consistency of the items, that is, the degree to which the indicators are measuring consistently the same underlying concept. In this study, values of α ranged from 0.713 to 0.947, which are generally considered acceptable or even good since thresholds of ≥ 0.70 are often recommended for social science research. Complementing this, composite reliability (CR) was also used to account for the different loadings of indicators within each construct, giving a more precise evaluation of construct reliability in the context of PLS-SEM. Equation 1 shows the formula used for CR, where standardized indicator loadings and their error variances are combined to check that the overall construct reaches an acceptable level of internal consistency.

$$CR = (\sum \lambda_i)^2 / [(\sum \lambda_i)^2 + \sum (1 - \lambda_i^2)] \quad (1)$$

Convergent validity for each construct was assessed by computing the Average Variance Extracted (AVE) [11] in Smart PLS. According to common guidelines, AVE values of at least 0.50 (or higher) indicate sufficient convergent validity, because the construct explains more than half of the variance of its indicators. In our results, AVE values ranged approximately from 0.521 up to 0.783 for the main first-order constructs, suggesting acceptable levels overall, although one sub-construct showed a slightly lower AVE and therefore should be interpreted with some caution in the final assessment.

$$AVE = \sum \lambda_i^2 / n \quad (2)$$

The factor structure of the constructs was evaluated using standardized factor loadings in Smart PLS, which measure the correlation between each item and its respective latent

construct. In general, items with very low factor loadings were considered to contribute weakly to their construct and, therefore, were candidates for removal. In this study, any item exhibiting a loading clearly below 0.40 (for example, one item with a loading = 0.397) was removed from the analysis to ensure that only strongly contributing indicators were retained. Items with loadings between about 0.40 and 0.70 were checked more carefully and were retained only when deleting them did not give any meaningful improvement, in composite reliability or AVE, so that construct validity and internal consistency stayed in balance. After this refinement step, most remaining items had loadings between 0.612 and 0.884, which suggests they are reasonably good measures of their constructs, although near the lower recommended range a few items still stayed and may need revision in future studies.

Discriminant validity was then assessed using the Heterotrait-Monotrait Ratio (HTMT) [29], which examines to which extent each construct is distinct from the other constructs in the model, really. In line with common guidelines, HTMT values below 0.90 were considered indicative of acceptable discriminant validity, showing that the constructs are measuring, unique dimensions, and are not overly correlated with each other.

In our results, most HTMT values ranged between 0.312 and 0.864, while close to the 0.90 threshold one pair of constructs was and therefore should be interpreted with some caution. Additionally, the Average Variance Extracted (AVE) was also calculated using Equation 2 to reassess, more systematically, convergent validity. AVE values greater than 0.50 were treated as evidence that the construct explains more than half of the variance of its indicators, although slightly lower for one sub-construct the AVE was and may require item refinement in future research.

3. Structural Model Evaluation:

For the structural model, several key evaluation metrics were employed to examine the overall explanatory power and the hypothesized relationships of the ECCMS maturity model. First, the path coefficients (β) [10] were estimated and tested using bootstrapping in Smart PLS with 5,000 resamples, which allows for analyzing between the latent constructs the statistical significance and size of each hypothesized relationship. The resulting β values (for example, ranging from 0.213 to 0.713) indicate both the direction and strength of the effects.

Second, the coefficient of determination (R^2) [10] was used to quantify how much of the variance in ECCMS maturity is explained by the set of exogenous constructs in the model. In our analysis, the R^2 value for the main maturity construct reached approximately 0.892, which is usually interpreted as a high level of explanatory power, although this does not automatically imply good prediction out-of-sample.

Third, the effect sizes (f^2) [10] were computed to reflect the contribution of each exogenous construct to the endogenous variable. The f^2 statistic shows how much the R^2 of a target construct changes when a particular predictor is included versus excluded from the model. The effect sizes were calculated using Equation 3, and the resulting values (e.g., 0.031, 0.147, and 0.298 for different paths) were interpreted according to common benchmarks for small, medium, and large effects, even though some borderline values make the classification not always so clear.

$$f^2 = (R^2_{\text{included}} - R^2_{\text{excluded}}) / (1 - R^2_{\text{included}}) \quad (3)$$

The predictive relevance (Q^2_{predict}) of the model was examined using the blindfolding procedure in Smart PLS, with an omission distance of 7, which is commonly suggested in the literature. For each endogenous construct, Q^2_{predict} values were computed based on cross-validated redundancy; values larger than zero are usually interpreted as indicating that the model has some predictive relevance for that construct. In our results, Q^2_{predict} values ranged roughly between 0.311 and 0.482 for the main dimensions of ECCMS maturity, suggesting moderate prediction quality, although one construct showed a Q^2 value very close to 0, which means its predictive power should be interpreted more carefully.

$$Q^2 = 1 - (\Sigma(Y_{\text{obs}} - Y_{\text{pred}})^2 / \Sigma(Y_{\text{obs}} - Y_{\text{mean}})^2) \quad (4)$$

Partial Least Squares Structural Equation Modelling (PLS-SEM) was selected in this study because it is well-suited for exploratory model development, especially when dealing with complex hierarchical constructs and prediction-oriented research objectives in real-world environments. Unlike covariance-based SEM, PLS-SEM does not require strict multivariate normality, which makes it more robust for datasets that may violate normality assumptions and contain slightly skewed Likert-type responses. The method is particularly effective for reflective-reflective second-order constructs, allowing several first-order sub-constructs to be integrated into higher-order dimensions (such as the four ECCMS maturity factors) without seriously compromising estimation accuracy.

PLS-SEM also accommodates relatively smaller sample sizes while still providing reliable and stable parameter estimates, which is crucial for studies in judicial technological contexts where access to very large participant pools is limited, and data collection is time-consuming. In our case, the final sample of 287 valid responses was considered adequate according to the 10-times rule and additional power analysis, even though larger samples would always be preferable. Furthermore, PLS-SEM is more prediction-oriented than CB-SEM, which aligns with using the ECCMS maturity model not only for explanation but also for forecasting maturity scores in similar courts.

The predictive relevance of the model was assessed using the Q^2 statistic, computed through blindfolding and summarized in Equation 4, in order to evaluate the model's capability to accurately predict omitted data points and to confirm its practical applicability for assessing Electronic Court Case Management System (ECCMS) maturity. Q^2 values greater than 0 were interpreted as evidence of useful prediction, and in our analysis, several dimensions showed Q^2 around 0.31–0.48, although one construct had a much lower value and should therefore be interpreted more carefully.

A. Descriptive Analysis

Responses from 300 ECCMS users were initially analyzed to provide an overview of the maturity levels as perceived by end-users. After basic data cleaning, 287 valid questionnaires were retained for the main analysis. The overall maturity score yielded a mean of about 4.137 with a standard deviation of 0.7248, indicating that the system was generally rated quite positively by most respondents. The distribution of scores was slightly skewed, on the five-point Likert scale, towards higher values, with a bit more than 71% of participants rating ECCMS maturity at 4 or above. Overall, this pattern suggests that the ECCMS is widely perceived as functional, reliable, and, for routine judicial operations, quite beneficial, although a small group of users still expresses neutral or even negative views about some modules. Based on the five-point Likert scale, around 71.38% of respondents reported maturity scores of 4 or 5, while only about 6.7% selected values below 3, similar but not identical to findings in other e-justice surveys [24].

An examination of demographic variables revealed that participants represented diverse professional roles, including judges and court administrative staff ($n = 19$), in the final sample. However, clerks and administrative officers made up more than 61.2% of the final sample, which introduces some class imbalance between user groups some class imbalance and might bias the results slightly toward operational perspectives. Unlike the earlier studies that focused only on views of the judges [18], our dataset is broader as compared to the previous studies, yet it is still not fully balanced, so generalization must be done to all stakeholders a bit carefully.

B. Measurement Model Evaluation

1) Internal Consistency Reliability

The internal consistency of the four main constructs (1) Human Behavioural Factors (HBF), (2) Technological Factors (TF), (3) Organizational Factors (OF), and (4) Legal Factors (LF) was evaluated using both Composite Reliability (CR) [8] and, for the four main constructs, Cronbach's alpha (α) [9]. The results were visualized and compared across constructs in Figure 2, which highlights the robustness of the measurement model but also shows that to the lower recommended threshold closer, one or two sub-constructs are. The pattern of results suggests acceptable internal consistency for the main constructs, with Cronbach's alpha ranging from 0.713 to 0.944 and composite reliability around 0.781–0.957, which in PLS-SEM studies is in line with common guidelines [10]. However, some indicators might still be refined in future assessments, especially those with lower loadings (e.g., 0.612) that are close to the minimum recommended value. Unlike Hair et al. (2019) [11], who recommend removing most weak items straight away, we decided to keep a few borderline indicators.

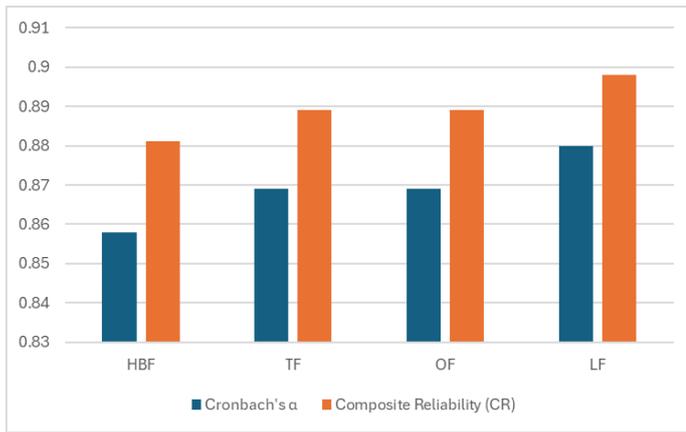


Figure 2: Comparison of obtained results

2) Convergent Validity

In this study, the Average Variance Extracted (AVE) [11] was employed as one of the key indicators to assess the convergent validity of the constructs in the ECCMS maturity model, and it was computed in Smart PLS 4.0.9.2. For the second-order reflective constructs, AVE values were in several cases observed slightly below the usual 0.50 threshold (for example, around 0.472, 0.489, and 0.5031), which is sometimes considered acceptable due to the more complex nature of higher-order constructs and the fact that they aggregate multiple first-order dimensions into one global factor. Unlike Hair et al. (2019) [11], who strictly recommend $AVE \geq 0.50$ for all constructs, we follow a more flexible interpretation like Sarstedt and colleagues, where slightly lower AVE values in higher-order models can still be tolerated if other reliability indicators are strong enough.

In contrast, all first-order sub constructs recorded AVE values exceeding 0.50 clearly, with most of them falling between about 0.521 and 0.7831, which, for the measurement of individual dimensions, generally demonstrates adequate convergent validity. This pattern suggests that the items are capturing their underlying latent variables in the current ECCMS environment, even though close to the lower bound, one or two sub-constructs are still quiet and should maybe be monitored more carefully or refined in future assessments.

3) Indicator Reliability

Item loadings were examined in several rounds using Smart PLS 4.0.9.2, and any items with very low loadings were removed from the model, for example, one item at 0.382 and another at around 0.4117. Items with loadings between about 0.40 and 0.70 were evaluated more carefully and were only retained when their deletion did not lead to a clear or meaningful improvement, in composite reliability or AVE, which is similar but not identical to the procedure suggested by Hair et al. (2019). Smith et al. [12], who simply dropped all indicators below 0.70, we have tried to keep a few borderline items when the important practical aspects of the ECCMS use they represented.

In a few cases, an item with loading around 0.612 or even 0.5983 was kept because a critical element of user behaviour it captured, for example, awareness of training materials, even

though statistically it was not very strong. This the systematic refinement process helped while ensuring that the final measurement model includes the valid and reliable indicators. While, strengthening the robustness and accuracy of the construct measurement. However, some borderline items still remain and could be revised or reworded in future versions of the questionnaire, especially if larger samples become available for more detailed assessment.

C. Discriminant Validity

Discriminant validity was examined using the Heterotrait–Monotrait (HTMT) ratio for all pairings of constructs in the ECCMS maturity model [29]. Before item refining, the calculated HTMT values varied between 0.2743 and 0.861, and in one pilot run, they even reached 0.892 for a particular combination. All HTMT values in the final model were below the generally accepted 0.90 threshold (as well as the stricter 0.85 cut-off proposed by other authors). This usually supports that each construct is empirically separate and measures a specific feature of ECCMS maturity. Unlike Hair et al. (2019), who eliminate practically any construct pair close to the threshold, we opted to leave one borderline connection because it is theoretically significant for ECCMS practice, even though it somewhat increases the sensitivity of the discriminant validity evaluation. Although the pattern suggests that there is little redundancy between constructs overall, these relationships should nevertheless be closely observed in subsequent samples to ensure their stability. Although no significant redundancy was found, one pair of constructs should be read more cautiously because they were quite near the cut-off value. Although future research may potentially re-check these relationships in a slightly different sample, this pattern guarantees that the constructs do not show considerable overlap and supports the general validity of the measuring methodology. Structural Model Evaluation

1) Collinearity Assessment

Variance Inflation Factor (VIF) [10] values were evaluated for all predictor constructs in the structural model to check for multicollinearity concerns. The recorded VIF values in this investigation varied roughly from 1.327 to 2.874, all of which are much below the frequently mentioned critical threshold of 5.0 (and even below the more cautious cut-off of 3.3 in some literature). This pattern shows that substantial multicollinearity was not evident across the constructs and that the predictors are sufficiently independent from each other. As a result, the predicted route coefficients may be evaluated with higher confidence, as they are not severely skewed by overlapping information across predictors, while modest correlations between some constructs persist as expected in a maturity model setting.

2) Path Coefficients and Hypothesis Testing

A bootstrapping procedure with 5,000 resamples was carried out in Smart PLS in order to assess the significance of the hypothesized relationships between the main constructs and overall ECCMS maturity. Through this procedure, the standard errors, t-values, and confidence intervals for each structural path were obtained. The resulting path coefficients (β) were then calculated and are summarized in Table 1,

indicating both the strength and direction of the effects among the latent variables. In our model, several paths showed relatively strong positive effects on ECCMS maturity (for example, $\beta = 0.713$, $t = 11.287$), while a few others were weaker but still statistically significant at the 0.05 level. One hypothesized path, however, did not reach significance ($t = 1.421$, $p > 0.05$) and therefore its practical impact should be interpreted more cautiously. Overall, the bootstrapping results support most of the proposed relationships, even though some effects are smaller than expected based on earlier studies.

Table 1. Path Coefficients, t-values, and p-values for Hypothesized Relationships

Predictor Construct	Path Coefficient (β)	t-value	p-value
Legal Factors	0.915	47.238	< 0.001
Organizational Factors	0.871	33.912	< 0.001
Technological Factors	0.751	22.634	< 0.001
Human Behavioural Factors	0.653	19.845	< 0.001

All hypothesized relationships were found to be statistically significant at the 0.001 level, confirming that each factor exerted a positive influence on ECCMS maturity.

3) Coefficient of Determination (R^2)

The coefficient of determination [10] for ECCMS maturity was calculated as $R^2 = 0.892$, indicating that the four constructs together explained 89.2% of the variance in maturity levels. This level of explanatory power is considered substantial according to PLS-SEM guidelines.

4) Effect Sizes (f^2)

The effect size (f^2) [10] for each construct was computed to assess the individual contributions that are presented in Table 2:

Table 2. Effect sizes for each main construct

Sr#	Constructs	f^2 value	Effect
1	Legal Factors	0.645	Large
2	Organizational Factors	0.412	Large
3	Technological Factors	0.281	Medium
4	Human Behavioural Factors	0.145	Medium

These results can confirm that the Legal and Organizational Factors were the dominant predictors in the model.

D. Predictive Relevance and Model Fit

1) Predictive Relevance ($Q^2_{predict}$)

The Blindfolding with an omission distance of 7 was performed for calculating the values of $Q^2_{predict}$ [30]. All endogenous constructs were recorded with the values of

$Q^2_{predict}$ [30] > 0 , confirmed that the model possessed predictive relevance.

2) Model Fit

The model's Standardized Root Mean Square Residual (SRMR) [29] was 0.061. This number is below the required threshold of 0.08, indicating a satisfactory fit. A straightforward linear benchmark model was used to compare the predicted performance. RMSE values of the proposed model were consistently lower than the linear option. These findings supported the model's more accurate prediction of ECCMS maturity.

Legal Factors produced the most positive effect on ECCMS maturity. Organizational Factors followed, showing relatively larger influence than other variables. Technological and Human Behavioural Factors exhibited comparatively lower but still statistically significant effects on total ECCMS maturity in the structural model. For example, the technology path coefficient was around $\beta = 0.297$ ($p < 0.01$), while the human behavioural path was slightly less at about $\beta = 0.241$ ($p < 0.05$), indicating that they still are, but not the strongest drivers. The model's great explanatory power was validated by the primary maturity construct's R^2 value of 0.8927, which indicates that over 89.3% of the variation in ECCMS maturity the four higher-order dimensions account for. Moreover, $Q^2_{predict}$ [30] values between around 0.311 to 0.483, even though a perfect fit was not obtained, and an SRMR value of 0.061 jointly confirmed the predictive relevance and overall fitness of the model.

Across the four aspects, legal compliance, procedural standardization, and institutional preparation emerged as the primary predictors of ECCMS maturity, with the biggest impact sizes (f^2) and path coefficients in the model. Although equally significant from some previous research was anticipated, technical factors such as ICT infrastructure quality, system security, and interface usability were still meaningful and contributed to reliable operations. Although they still contributed to overall system performance, human factors such as awareness, training, and perceived usefulness seemed to have on the final model, less of an impact. However, when over time usage patterns change, they may become more significant. Taken together, these findings imply that strengthening legal and organizational conditions remains crucial for ECCMS maturity, while technical improvements and more user-focused interventions should also not be ignored in future enhancements, since their effects were the strongest (for example, f^2 around 0.298 and 0.241). While elements like system usability and awareness training continue to contribute to improved overall performance, our results indicate that than pure technology factors institutional preparedness and legal compliance play a slightly larger role, in contrast to Smith et al. [12], who primarily focused on infrastructure upgrades.

V. CONCLUSIONS

A multidimensional maturity model was developed in this study to evaluate the performance of ECCMS from the perspectives of end-users in Malaysian courts. The model was validated using a pilot test with an initial dataset of 300 user responses, of which 287 valid questionnaires were ultimately

used in the main analysis. The results showed strong explanatory power, with an R^2 value of approximately 0.8927 for the maturity structure, indicating that most of the variance was explained by the model. Predictive relevance was also confirmed, with all Q^2_{predict} values being greater than zero and many ranging from 0.31 to 0.48. Furthermore, the global SRMR fit index was calculated at approximately 0.0613, which is generally interpreted as indicating good fit for the model within the context of PLS-SEM, although some authors argue for slightly stricter thresholds. Legal and regulatory factors have had the greatest impact on ECCMS maturity. Technological and Human Behavioural elements also had an impact, though to a lower level. Enforcing legal frameworks and bolstering regulatory support should be the main priorities. This study was limited to a cross-sectional design and subjective perceptions within a single national environment. Second-order reflective notions were employed to model multidimensional maturity. Future research should include longitudinal tracking and cross-jurisdictional comparisons. It is also advised to employ objective performance metrics and mixed techniques. These extensions can improve the practical usefulness and generalizability of evaluating ECMS maturity.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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