

Technological Support for Correcting Exams: The Continuum Paradigm

Next step forward to build a holistic continuous audit model

Ed Curfs and Eric Mantelaers

Future-Proof Auditor
Zuyd University of Applied Sciences
Sittard, the Netherlands
ed.curfs@zuyd.nl
eric.mantelaers@zuyd.nl

Martijn Zoet and Clint Wolfs

Future-Proof Financial
Zuyd University of Applied Sciences
Sittard, the Netherlands
martijn.zoet@zuyd.nl
clint.wolfs@zuyd.nl

Abstract—Continuous Monitoring, Continuous Auditing, Continuous Assurance, Continuous Reporting and the Continuum Paradigm (CP) are the elements in which research has been performed over 30 years. A major part of the research was focused on individual elements of the CP. However, no research has been performed with the purpose to identify if it is possible to build a holistic audit model based on the CP. Researchers noticed that there are no global standards available yet, approved by the stakeholders in relation to Continuous Assurance or Continuous Reporting. In this paper, we developed and built a simplified and holistic CP, the case study, for the four building blocks of the CP: Continuous Monitoring, Continuous Auditing, Continuous Assurance and Continuous Reporting. The case study is based on an exam for the post-doc education program for Financial Auditing at Dutch Universities. An exam has been selected as this makes it possible to verify the performance of the model by verification of the machine (case study) versus the manual results. The overall conclusion is that there is a correlation between the results of the machine and the manual results of the examiners. However, the score of the machine is structurally lower than the manual scores of the examiners. The case study proves that it is possible to build an audit model, with reference to the technological support for correcting exams, based on the CP.

Keywords—case study; continuous monitoring; continuous auditing; continuous assurance; continuous reporting; continuum paradigm; reporting; forensic; financial auditing; financial data and non-financial data; machine review; manual review; sustainability reporting; testscripts.

I. INTRODUCTION

Due to cost-reduction programs, the increase of the labor costs, the shortage of skilled and educated professional financial auditors, increase the need for implementation (AI), ChatGTP, data analytics, process mining and also the further development of the CP. These advances are resulting in the creation of added value for the management of organizations and their stakeholders.

However, the process of the implementation of the CP is on-going for more than three decades [1] [8] [9]. Nonetheless, a holistic continuous audit model based on the CP has not yet been designed, built, and implemented. In the past, research has mainly been focused on non-financial data [1]-[3] although the first goal of the CP is to provide assurance of financial data, the annual statement of a

company or even ‘continuous’ published financial figures of the company. Based on the current development in law and regulation, the importance to get insight in a holistic continuous audit model increases. For the individual elements of the CP, a lot of research has been performed [1]-[3][5][6][8]. The goal of this case study is to develop the CP as a holistic system in a pragmatical way. Based on the outcome of the case study, professionals and researchers will gain a better understanding of the actual status and the missing building blocks to achieve a successful implementation of the CP at a larger scale.

The remainder of this paper is structured as follows. Section 2 summarizes the results of the literature review. The research method is described in Section 3. In Section 4 the data collection is described. The results are described in Section 5. Section 6 describes the conclusion. Finally, the paper concludes in Section 7 with the limitations and future research.

II. LITERATURE REVIEW

The four building blocks of the CP are (1) Continuous Monitoring (CM), (2) Continuous Auditing (CA), (3) Continuous Assurance (CAss), and (4) Continuous Reporting (CRe). A lot of research has been performed to each element from several different views and perspectives, however, so far, no research has been performed on all the elements of the CP as a whole.

The need for ongoing, timely assurance of data and information utilizing CM, CA, CAss, and CRe is becoming more apparent. To improve the readability of the article the abbreviations are presented in Table I.

In the last decades, Vassarhelyi, Kuenkaikaw, Alles and Willems performed research in the area of CM, CA, CAss, and CRe [1]. This research was mainly related to financial data and limited to one single element of the CP, e.g., CM or CA. Due to new applicable law and regulation non-financial data becomes more and more relevant. These new developments, in combination with the IT developments and the shortage on the labor market, place pressure on further development of a holistic system of the CP as an audit model.

To build a holistic CP [1][8][9], making use of real data, has not been achieved yet since the following standards are missing. Global accepted standards with regards to CM, audit and assurance standards related to classification of CA,

and reporting standards for CRe are not yet defined and approved by the related international bodies.

Alles et al. performed research in the area of Continuous Monitoring of Business Process Controls (CMBPC) [2]. Architecture has been developed to build a complete independent CMBPC system running on top of the Siemens' own enterprise information system. This pilot showed that it is feasible for a large internal audit department to implement a vast array of CA-type procedures to mitigate business risks in certain high impact areas, and to achieve labor savings through automation of internal audit tasks. Based on a detailed investigation of this pilot the outcome is that certain SAP reports related to logical access, including all parameters and changes of these parameters, have been developed, including red flags. These red flags require further investigation of the internal auditor of Siemens. This task results in a judgment of the auditor, is related to CA and is associated to audit the reliability and sustainability of the internal control system. This is one of the four so-called General IT controls. The elements CM, CAss and CRe were not part of this pilot.

Kogan, Sudit and Vasarhelyi investigated the status of Continuous Online Auditing (COA) in 1999 [3]. The outcome of the program of research was that further research needed to be performed in the areas of general architecture. In addition, future research should explore and design standard formats for enterprise data to facilitate data capture for COA. Furthermore, future research should focus on investigating the trade-offs, exploring the extent to which the auditor can rely on COA and investigating whether the use of COA is more likely to be initiated by internal than external auditors.

Recent research has been performed by Canning et. al [4] in the area of processes of auditability sustainability assurance. The purpose of the case study was to provide a better understanding of how financial audit concepts are translated in the sustainability assurance arena. A total of fourteen semi-structure and in-depth interviews were conducted with sustainability assurers who had financial audit training and experience or were specialists in other areas. These interviews were conducted between the period March and July 2013. Based on the information received, the audit of non-financial data is mainly performed manually, making limited use of IT solutions. Furthermore, it became clearer that financial auditors also choose to switch from financial audit in order to specialize in non-financial audit domains as for example corporate sustainability reporting. Explicitly examining their intrinsic motivations for switching, their experiences, and the influence they seek to bring to bear on assurance practices in new spaces, including materiality assessments, would be a fruitful avenue for future research.

The interest for the CP increases and research has been performed also regarding Forensic Continuous Auditing (FCA) by Kearns and Barker [5]. The conclusion of the research was that there are cogent reasons for adopting a system of forensic continuous auditing. Experience has shown that the traditional financial audit is not an effective mechanism for uncovering fraud [5]. The forensic

continuous audit system resulted in creation of control reports.

Eulerich and Kalinichenko [6] investigated the current state and future directions of CA research and one of the conclusions was that very specific applications for CA were investigated and the pragmatical added value for a general internal audit function may be limited. This situation cannot be acceptable and requires further research and investigation. The focus should be on pragmatical and practical applications for CA. Based on our review of the available research, we noted that limited results have been booked regarding the development and design of a holistic audit model based on the CP. We would like to investigate if there are pragmatical simplified cases available to perform a holistic test that takes all elements of the CP into account.

TABLE I. OVERVIEW RELEVANT ABBREVIATIONS OF THE ARTICLE

<i>Abbreviation</i>	<i>Description</i>
CA	Continuous Auditing
CAss	Continuous Assurance
CM	Continuous Monitoring
CMBPC	Continuous Monitoring of Business Process Controls
CP	Continuum Paradigm
COA	Continuous Online Auditing
CRe	Continuous Reporting

Based on the literature review it can be concluded that all elements of the CP have been heavily investigated as stand-alone components. No attempt has been made to investigate several elements simultaneously or build a simple model to prove the CP design and concept as a holistic audit model. The main reasons that no integrated holistic research has been performed are: (1) there are no global standard for monitoring internal controls, (2) there are auditing standards, for internal and external auditors, however these are always tailored per engagement / customer, (3) there are assurance standards, for internal and external auditors, however the professional judgment of the auditor is a complex process, based on data of several sources, and (4) there are reporting standards, auditors opinion, however these are the results of the auditing standards and the professional judgement of the auditor.

The goal of this research is to build, an audit model based on a case study. The model of the case study and the relation with the basic principles of the CP will be explained in detail in Section 3.

III. RESEARCH METHOD

The goal of this research is to build a holistic audit model based on the CP. The first step was to find an example or process that could be used to investigate all or nearly all buildings blocks of the CP. To make this possible, the team of three researchers investigated the options for simple processes that currently are performed manually. The team of researchers existing of 1) a junior researcher, with broad experience in internal and external auditing, 2) a senior researcher (PhD) with broad experience as external auditor

and 3) a senior researcher with broad experience on business rules management has been established. In addition, the processes should contain both financial as well as non-financial data. Moreover, it should be technically possible to automate the manual process. Lastly, the manual tasks should be linked to the building blocks of the CP.

The case study should provide insight in how a manual process could be transferred to a holistic audit model, based on the building blocks of the CP. This manual process should be based on the following tasks, (1) monitoring of a subject, (2) auditing of a subject, (3) defining achieved level of assurance based on the pre-defined standard and (4) reporting of the outcome. A manual process that could be used, is for example the review and judgment of written exams. By automating this process, it would be possible to compare the results of the manual process and the results automated process. The most important reasons for selecting the process of a written exam are (1) this is a simple process and (2) the tasks to be performed manually can be linked one to one to the building blocks of the CP.

In the manual process, an examiner is reading ten or more written exams, exam by exam and answer by answer. In practice, this task is performed over a period of several days as a stand-alone task. If the task can be performed for more than two exams simultaneously, it could be defined as a continuous task. The next task, the assessment of the content on one answer versus the content of the standard solution guidance has been linked to the building block CA. Audit is the verification of an outcome, result versus a pre-defined accepted standard. For the case study, the standard used is the standard examination guidance. The following manual task, calculation of the result of a written exam has been linked to the building block CAss. The outcome of an exam can be compared to the outcome of a financial audit. The auditor provides a certain level of assurance. In basic terms, there are two options (1) a qualified opinion or (2) a not-qualified opinion. The next manual task of recording the final result of a written exam per candidate corresponds to the building block CRe. More specifically, the knowledge level per topic per candidate is reported.

The CP includes the judgement process in the combination of the building blocks CM, CA and CAss. In Table II a high-level overview is presented with regard to the relationship between the building blocks of the CP and the manual tasks performed by reviewing written exams. There is a one-to-one relationship between the assessment process and the four building blocks of the CP.

The goals of the public auditor exams (as applicable in the Netherlands) are development to verify the level of actual competences about e.g., risk management, internal control, customer acceptance, materiality, audit approach, law and regulation, audit methodology, audit techniques, and professional judgement. The development of professional judgement is to improve the process as well as the quality of decision making, as investigated by Vaassen and Bröcheler [7]. Their research has been performed in 1996 and is based on the internal control exams. The research approach has partly been used as a reference for the development of the script. The script is a computer script that automates the

manual assessment process. The script makes use of predefined topics. A topic is related to a task a financial auditor performs. Table V provides an overview of the 18 defined topics. The script also contains the counting mechanism per question and the counting mechanism in total, based on the allocated points per word, figure and abbreviation per question. This results in a standard score per question, is shown in Table III. In addition, this results in a score per topic, which illustrates the knowledge level per topic.

TABLE II. ELEMENTS IN SCOPE TEST SCRIPT

<i>The Continuum Paradigm</i>			
<i>CM</i>	<i>CA</i>	<i>CAss</i>	<i>CRe</i>
<i>The Exam Gambit morning and afternoon session of the population in total 33.</i>	<i>The test cript based on the standard examination guidance made by the developer of Exam Gambit. The test script has been developed and reviewed by the 3 researchers.</i>	<i>Based on the points per question and the valuation as defined in the test script per candidate a results is presented.</i>	<i>The results per candidate is presented in an overview of achieved knowledge level per topic.</i>

Since this research is based on the internal control exams, we searched for exams with more or less the same design, structure and review process. The researchers decided to select the evaluation process of Financial Auditing exams made by students of the Dutch post-doc program Auditing. The reasons that this evaluation process has been selected are that the following data are available: (1) a case and written exams as input and subjects to be audited, (2) the rating methodology and method, (3) a standard examination guidance prepared by an independent audit professional, (4) general accepted guidance and rules for evaluation of the cases and defining the final judgement.

The next step was to select a representative exam to build the case study. Based on the selected exam, universities can be contacted to request the results made by the student for that specific exam. The Dutch National Exam Auditing of summer 2022, Exam Gambit, has been selected to build a model for the four building blocks (CM, CA, CAss and CRe) of the CP.

The main reason for selecting the Exam Gambit is that this is the most recent exam and represents the instances required by the auditing profession as well as the program of requirements defined by the Dutch Auditing Profession. This exam has also been selected as this relates to financial data as well as non-financial data. Exams in the context of, for example, psychology studies, teacher training, law studies, engineering studies, construction studies, chemical studies, languages, are less suitable because they often do not relate financial and non-financial data. The researchers are of the opinion that the CP should be created via a case study for both types of data. In the near future, due to developments related to the development of global law and regulation, both will require continuous attention. Furthermore, the data

elements of the Exam Gambit (two parts, morning, and afternoon session) are available. These are the exam, the standard examination guidance of the Exam Gambit, the valuation of the questions of the morning and afternoon Exam Gambit, the rating / assurance level of the National Exam (the regulation), the exams made by the students and the guidance how the results are presented to the accountable Professor of the university and the students.

The researchers are aware of the fact that building a case study for one exam of a post-doc program still is not a fully continuous process of monitoring the results and performance of a student during the whole post-soc program. However, this will be a simpler task to be automated. A calendar, a timetable of the post-doc program and results of a student are the data elements to be combined into one dashboard.

A. Manual Judgement Process

The case for the Auditing exam is prepared by one of the seven universities in the Netherlands accountable for the post-doc program Auditing. Cases are made on a rotation base. Each exam exists of a morning session and an afternoon session. For each session, the candidates can spend 3 to maximum 3,5 hours, depending on the standard defined by the exam developer. The morning and afternoon session of the Exam Gambit counted each four questions and for each session, 50 points were allocated. In case the candidate collects for one session more than 27.5 points in total and for the other more than 22.5 points in total, resulting in 50 points out of 100, the candidate passes the exam Auditing successfully.

The evaluation and judgement process for the exams Auditing have been the same process for several decades. The team of examiners are receiving the exams of maximum 10 students. Each case is reviewed by two independent examiners. One of the examiners is in the lead and receives the results of the second examiner.

B. Automated Judgement Process

The script designed is based on the standard examination guidance. The standard examination guidance (the answer) is based on two components per question. One component is referring to the regulation and standards and the second component is referring to the activities to be performed. The professional international auditing standards as well as the Dutch, ‘Controle en Overige Standaarden’ (COS), and the Dutch laws and regulations such as ‘Richtlijnen Jaarverslaggeving’ (RJ) are applicable. For each question, the applicable regulations have been defined and per regulation a decision rule has been created.

In the standard scheme guidance is provided regarding the standards, financial figures and per question a description of the correct answer in general. Per answer the standards, the main key-words and the financial figures have been used to define the decision rules. One standard or one man key-word or one financial figure results each in a decision rule. For question 1 in total 102 decisions rules have been developed.

For each question, the total points to be granted, based on the standard examination guidance, have been divided by the defined number of decision rules per answer. In Table III, the final maximum score per question is presented.

The draft script has been prepared by one researcher and two researchers reviewed independently the (draft) scripts, during each stage of the development process. The first version of the script, existing of 1,004 decision rules for the Exam Gambit, has been tested making use of the 6 cases of University I. Out of the 33 cases ad-random the cases of three candidates have been selected that passed the exam and three candidates that did not pass the exam. Based on the analysis performed, the researchers notified that 249 predefined decision rules were not mentioned in one of the 6 cases prepared by these candidates. These 249 decision rules influence negatively the score per candidate with 17.5 points out of 100. The first test script has been validated and cleansed, resulting in 755 decision rules

TABLE III. STANDARD SCORE AND SCORE TEST SCRIPT

Question	Session	Score based on standard scheme	Number of decision rules	Score per decision rule
1	Morning	10	102	0.0980390
2		10	76	0.1315790
3		10	97	0.1030930
4		20	177	0.1129940
Total Score Morning		50	452	
5	Afternoon	15	45	0.3333300
6		10	82	0.1219510
7		15	75	0.2000000
8		10	101	0.0991000
Total Score Evening		50	303	
Total		100	755	

The outcome of the second test was reliable and could be used for the total population of 33 candidates, 66 cases. The designed CP has been accomplished for the 66 cases. The results and outcome have been presented in this article.

C. Relationship manual versus automated Judgement Process

The manual process consists of providing the cases to the reviewers, the manual review, the manual calculation of the rating, the manual judgement and manual reporting of the outcome. This process normally takes several weeks. The relation between the automated versus the manual process is that based on the case study, it can be concluded that the monitoring task (collection of the written exams), the review task (audit), the judgement task (assurance) and the final outcome (reporting) of exams (monitoring) can be performed simultaneously and continuous for an unlimited number of exams. The automated process takes less than one minute for 66 exams. The automated process can be repeated at any time, any moment and at any location.

D. Link to future performance of the auditor

During the evaluation of the first version of the test script the researchers thought that it might be also possible to define a relationship between the tasks a financial auditor

performs on a day-to-day basis and the Exam Gambit. The defined topics are related to audit elements, audit work, audit approach, audit techniques. These are all tasks that a financial auditor will perform during an engagement. For each decision rule (in total 755) a topic has been defined. During the first attempt accomplished by one of the researchers' 25 topics were defined and allocated. The review of the other two researchers resulted in final 18 topics. See Table V the 18 topics that have been defined. About these 18 topics the same rating methodology has been used as for the 755 decision rules.

IV. DATA COLLECTION

There are seven universities in the Netherlands providing educational skills and training for the post-doc program Auditing. We contacted the University I with the request to provide to us the cases Gambit prepared by the candidates.

University I provided us with the following data: (1) the total population of the candidates are 35. Two of the candidates did not participate in the Auditing exam summer 2022, (2) the exams of 33 candidates who completed the morning and afternoon session of the Case Gambit, summer 2022, (3) the results per candidate for the Exam Gambit. The results according to the first, as well as the second examiner have been provided. All the provided data have been anonymized in line with applicable global law and regulation.

The overall exam results of all seven universities in the Netherlands normally varies between 60% and 75% of the total population that passes the Auditing exam. The candidates are a mix of candidates that make the Auditing exam for the first time and repeaters. The number of repeaters per auditing exam is a small part of the population. For the auditing Exam Gambit at University I, 19 candidates passed the Exam successfully (58 %) and 14 candidates did not (42 %).

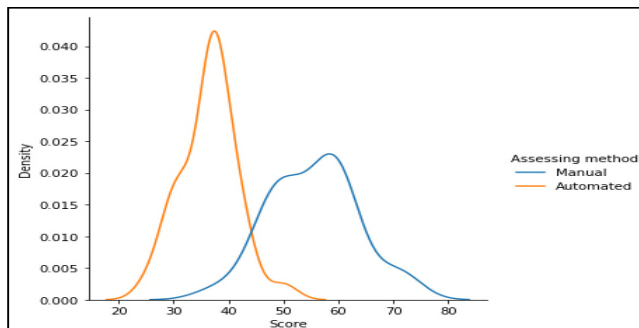
V. RESULTS

By designing and building a script for an exam, it is possible to combine the following building blocks of the CP: CM, CA, CAss and CRe into one model. The case study proves that it is possible to achieve a holistic audit model based on the CP. The manual process of reviewing written exams can be automated based on the CP. The case study can be repeated for all written exams during the complete study program of several years at any university. However, this was not part of the case study as this is only one the many exams a student needs to pass.

TABLE IV. CORRELATION RESULTS

	Total decision rules	Result machine	Result manual
Total decision rules	1.0000000	0.8329330	0.5669460
Result machine	0.8329330	1.0000000	0.6237030
Result manual	0.5669460	0.6327030	1.0000000

FIGURE 1. RELATIONSHIP RESULTS AUTOMATED VERSUS MANUAL



The results of the case study based on the population of 33 cases University I are (1) there is a correlation between the results of the machine (case study) and the results of the corrector (value of 0.6237030, see Table IV), (2) the scores of the machine are structurally lower than manual scores of the examiners (see Figure 1.) and (3) it has been proven that it is possible to build a pragmatic integrated CP.

Out of the original defined 1,004 decision rules, 249 decision rules have been removed after the review of the other two researchers.

TABLE V. KNOWLEDGE LEVEL PER TOPIC FOR ALL EXAMS

Nr	Topic	%
0	Initial audit engagement	65.00%
1	Audit statement	38.96%
2	Dat oriented audit approach	25.25%
3	Internal control	45.03%
4	Materiality	29.76%
5	Reporting	42.42%
6	Acceptance of the engagement	28.01%
7	Quality assurance	30.23%
8	System oriented audit	45.45%
9	Tendency	67.42%
10	Law and regulation	44.68%
11	Audit work related to opening balance	23.43%
12	Audit work related to findings	47.33%
13	Audit work related to financing Gambit	38.18%
14	Audit work related to financial regulation (shift) risk	45.26%
15	Audit work related to provisions	25.33%
16	Audit work related to projects	38.66%
17	Audit work related to shifting turnover and costs	9.09%

Based on the 18 topics and the evaluation of the scores of these topics, it is possible to provide insight in the average knowledge of the total population of these (individual) students. For example, the topic (0) Initial audit engagement results in a score of 65 %. The result 65 % implies that the average knowledge level per student is good. In case the result for a topic is below 50 % it could mean that the current knowledge of the student regarding this topic is not up to standard or that the education of this topic is not sufficient.

VI. CONCLUSION

Based on the results of the investigation, it became clear that building a holistic audit model, useful for financial

auditing is a very complex process and that global standards regarding monitoring, auditing, assurance and reporting for building a model are missing. Due to these factors, the researchers decided to find options and scenarios to be used to design a holistic audit model based on the CP. On the other hand, because global accepted standards for CM, CAss and CRe are missing, and that each organizations have its own tailor-made processes and systems in place, one standard CP for example the automotive industry will not fit in. The boundary condition will be that all companies of a specific industry need to align their business standards with the specific elements of their processes and systems of the industry.

The outcome of the case study is that this is the first time that the building blocks of the CP have been developed as a holistic audit model. This is a simplified model and provides insight in the missing elements per building blocks for further successful developments in the area of the implementation of the CP for auditing.

The results of the case study are (1) there is a correlation between the results of the machine (case study) and the results of the corrector (value of 0.6327030, see Table IV), (2) the scores of the machine are structurally lower than manual scores of the examiners (see Figure 1). There is also a correlation between total decision rules and result machine (value 0.8329330) and the result manual (value 0.5669460). The correlation of the machine result is higher than the manual result. The next result (3) it has been proven that it is possible to build almost a holistic audit model based on the CP model.

By an automated evaluation of an exam, the researchers made it possible to also provide insight in the development level of students about specific tasks a financial auditor performs during the operational process of auditing the financial statements of a client. Automated evaluation of written exams makes it possible to provide insights over more demission's than the standard evaluation. This data could be used to improve the overall quality of the education program as part of the post-doc program and to coach the student in a more focused and tailor-made approach. The long-term result could be that the maturity level of the next generation of Certified Public Auditors increases.

VII. LIMITATIONS AND FUTURE RESREACH

The case study is the first attempt to design and build a holistic audit model based on the CP, for financial as well as non-financial data. However, there still are several limitations that should be taken into consideration while interpreting the results.

The first limitation is related to the representation – the significancy of the correlation. The difference between the machine and examiners has not been verified based on statistical testing. This testing is needed to achieve the representatives of our results. A second limitation relates to the validation of the decision rules. Out of the 755 decision rules, 128 decision rules have still not been used in the tested 66 cases. This could imply that the knowledge level of the students is low or that the decision rules are not valid. Moreover, it could also be that the standard examination

guide provided by an independent professional in auditing is incomplete or overcomplete. Another explanation could be that the expectation level of the professional is not in line with the achieved knowledge level.

Based on this research and the case study, further research is needed to identify if the CP is the best way for continuous monitoring the performance of processes of organizations and more specifically, the financial audit process. Another option could be that the money part of the good and money model of Starreveld [10] will be a better and more practical hybrid option. This conceptual model has the advantages that the continuous monitoring is based on the following data: (1) incoming payments, (2) outgoing payments and (3) development of one or several general ledgers accounts: for example, bank and external obligations (loans). These financial data are available on a minute-to-minute base and a major part of the data are structured, which is founded on global standards. These financial data are transferred from the company and the external finance companies daily. Therefore, all the related process risks, internal controls and data transfer do not need to be continuous monitored, audited, and assured to achieve reasonable assurance of these financial data. Correspondingly, data of previous years is available, and these data can be used as an assurance framework to identify major deviations or out of the benchmark postings.

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