# Flexible Support System for Email-based Processes: an Empirical Evaluation

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***Abstract*- In many companies, a majority of business processes take place via email communication. Large enterprises have the possibility to operate enterprise systems for a successful business process management. However, these systems are not appropriate for SMEs, which are the most common enterprise type in Europe. Thus, the European research project Commius addresses the special needs of SMEs and characteristics of email communication, namely high flexibility and lack of structure. Within the research project, the prototype COPA was developed as an email-based workflow solution. In the course of this paper, we present an evaluation of the prototype that was led by three stated hypotheses demonstrating the utility, quality, and efficacy of COPA in practice. As a result, all hypotheses could be verified due to the significantly faster and easier execution of the evaluation workflow as well as the higher satisfaction of the subjects regarding their achieved workflow result in contrast to a common non-COPA supported workflow execution. Furthermore, subjects agreed with general statements on COPA and judged the integration into the existing email landscape as a very useful feature. Consequently, COPA seems to be a feasible approach to manage email-based business processes in SMEs.**

***Keywords- Email; Workflow; Business Process; Flexibility; Design Science; Evaluation***

## I. INTRODUCTION

Email communication has become an integral part of our daily business activities, without which modern business would be unthinkable. On average, each employee spends 2.6 hours a day with sending and receiving 33 respectively 72 emails [7], [26]. However, not only the time spent with emails as a means of communication, but also the knowledge that is bundled without structure in companies' email repositories is very difficult to manage. This becomes clear, if the number of 75 % is taken into mind representing the percentage of a company's knowledge saved in email messages [19].

As a direct consequence, there is a need for software solutions to effectively manage email messages representing an important resource for companies. If employees spend 1/3 of their time with email communication and 3/4 of a company's knowledge is stored in email inboxes, it can be concluded that in many companies a majority of business processes take place via email communication. Large companies have the possibility to operate enterprise systems, for instance ERP systems, which contain features for a successful business process management. Nevertheless, these solutions are not appropriate for all types of companies. Small and medium-sized enterprises (SMEs)—that account for 99 % of the entire European enterprises with almost 70 % of all employees [24]—do mostly not have the ability to spend money for purchasing, operating and maintaining such expensive systems [8].

Currently, hardly any of the existing software solutions addresses the special needs of SMEs that require solutions with low purchasing costs (the best would be almost zero start-up costs) resulting in a quick Return on Investment, less operation costs without the need for additional employees who continuously adapt the solutions to specific needs as well as a software environment that does not require a long training/learning period for users to be able to work with the software [2].

Consequently, the development of a solution that hooks on an existing email communication environment focusing on SMEs seems promising. However, email-based business process solutions would have to address the special characteristics of email communication, namely high flexibility and lack of structure. Traditional workflow engines lack the required flexibility for reacting to ad-hoc changes [10]. Their rigid underlying process model would need to foresee all possible variation, which becomes unfeasible even for simple processes. On the other hand, flexible workflow engines (for an exhaustive survey on flexible business process systems cf. [4]) expect user knowledge about the procedural structures of an enterprise and do not provide enough guidance. However, introducing more procedural structures would result in a decrease of a system's flexibility [25]. Due to these problems, none of the proposed solutions could be successfully established on the market [10].

The European-funded research project COMMIUS (acronym for COMMunity-based Interoperability Utility for Small and medium enterprises) addresses these particular problems [5]. The proposed concept manages email-based business processes and is tailored to the special needs of SMEs. The prototype COPA (acronym for COllaborative Process Assistant) implements the concept of Commius. COPA copes with the high flexibility as well as personal and company individual requirements of email communication. Consequently, COPA has the target to make email-based workflows easier, faster and more structured. However, within the design science paradigm in information systems research, solely constructed IT-artifacts are not a valid research result per se. Therefore, this paper presents an empirical evaluation of the prototype COPA trying to clarify whether the basic principles behind the Commius research project can be beneficial in practice.

Initially, while Section 1examines related work in the field of Commius, Section 2 forms the basis of this paper by introducing the concept of Commius in more detail. In Section 3, the need for evaluations within the design science paradigm in information systems research is explained as well as the setting of the evaluation introduced. Finally, Section 4 presents the findings of the conducted evaluation. The paper closes with a conclusion and outlook in Section 5.

## II. RELATED WORK

The importance of developing a flexible process support system tailored for the needs of SME is underlined by a multitude of research projects and software prototypes addressing this issue. The Group-Process Project [13] enables the user to create on-the-fly modeling of workflow processes, in which tasks are not assigned to organizational units, but to specific persons, through a Java-based graphical modeling interface, in order to reorganize weakly structured processes. In this context, the Endeavors project [14] from the University of California (UCI) or Hanuri/TFlow [11] from the School of Engineering Korea have to be mentioned as well, since they follow a similar strictly workflow-orientated approach like the Group-Process Project. Although the approach introduced in this paper also comprises a workflow component due to its action triggered process handling, its respective focus is on a more holistic view of the processes rather than just the workflow component. The Open Water Project aims at tracking and monitoring email activity in order to create a knowledge database consisting of past process activities. Based on past work-sequences, emails can be forwarded to the most common recipient [22].

In contrast to the approach addressed above, only the next step is taken into account, while COPA focuses on the complete workflow. The "reinventing email" project from IBM follows the idea of enriching emails with useful additional services like integrated document processing or highlighting of information within emails [9]. The P2E2 project follows the approach that a cross-organizational business process can be subdivided among the participating organizations, with each partition having exactly one actor responsible for it, and with interface elements between two partitions appearing on both sides. Due to this subdivision, every actor contributes his very own process-part to a comprehensive cross-organizational process [27]. Although this orchestration of process parts into a cross organizational process is of high interest, COPA processes cannot be predefined in such a way due to the high need of flexibility of most SMEs. The similarity of this concept with the assisting functionality may be of use for the further evolvement of the project. Other approaches to implement context-sensitive information into email can be seen in projects like kMail or Zimbra. kMail provides a special tool (which constitutes the main difference to COPA) implementing organizational memory and knowledge into emails [15], while Zimbra, a web-based client, is able to detect relevant information like names or telephone numbers and use them in some predefined operations [30]. Nevertheless, none of these approaches provides a holistic commercially available solution, flexible enough to match the needs of SMEs in particular with regard to email communication.

## III. Approach for an Email-Based Business Process Support

The European-funded research project Commius addresses the special need of software solutions, tailored explicitly for SMEs, raised within Section 1. As an approach towards an innovative solution in this field, the prototype COPA implements the concept of Commius and aims at supporting users in email-based business processes. Therefore, it automatically hooks onto the existing email infrastructure and collaboration systems, such as Microsoft Exchange, and assigns incoming emails based on their content to new or already running processes. Furthermore, to support the process execution, the emails are enriched with additional information and recommendations regarding further steps within the assigned business process. The configuration tool of COPA, which is presented in Subsection A, allows the implementation of a company's business processes in an easy and interactive way without in-depth IT knowledge. The actual process support can additionally be adapted in terms of type and scope to the particular user needs and behavior as well as application domain. As COPA addresses in particular the needs of SMEs, the system has almost zero start-up costs in terms of both resources and learning. Furthermore, the operating costs are kept low based on the fact that COPA will automatically evolve with an organization, adapting to its users' needs and according to existing ICT infrastructures.

From a more technical perspective, COPA is divided into three main layers that are introduced in the following:

- On the level of the *system layer* each received email of an enterprise will be intercepted by the COPA system and subsequently be analyzed, archived, decoded and decomposed. Each part of an email, i.e. headers, body or attachments, will be transformed into plain text and merged into a single XML document to allow other COPA components to directly access the information for further processing. In addition, the system layer will provide system connectors usable to interface external as well as legacy systems, required to be accessible by COPA throughout a task.
- The *semantic layer* signifies meaningful communication of the enterprise. As such, it also underpins the interoperability between collaborating enterprises. Outgoing from pattern based information extraction—using e.g. regular expressions—notifications, invoices, payments, orders and other communication can be identified and relevant information will be extracted.
- The *process layer* concerns process interoperability and constitutes the main part of this paper because user interactions take place mainly with this layer. Thus, it must be addressed more detailed in this section regarding the evaluation of an end-user prototype within this paper. The layer is subdivided into four run-time components and one build-time (configuration) component, which are described in the following subsections.

### A. COPA Configuration (Build-Time)

To be suitable for the specific requirements of SMEs and to provide best and prompt assistance, COPA processes have to be highly adaptable in a fast and user-friendly way. Hence, the developed process configuration tool allows optimal fitting of disposable process templates. COPA provides a Reference Model Directory containing adaptable business processes templates for a diversity of SME's standard processes like selling, invoicing, etc. These templates can be customized in two ways. If the standard process provided by COPA sufficiently represents the actual workflow of a company, i.e. there is no need for far-reaching customization effort, COPA will query only most important information that is necessary for a definition of certain aspects. This information will be retrieved by using a questioning system. Major changes of the standard templates, on the other hand, can be performed using an easy-to-use graphical modeling interface, which is based on drag and drop functionalities. Thus, the user has a best possible opportunity to (gradually) customize business processes. Independent from the applied customization method, the adapted processes will be stored in the *Enterprise Process Repository* reflecting very own specifications and will later serve as input for assisting and advising functionalities.

*B. COPA Operation (Run-Time)*

Having defined own process settings, the COPA system can be employed. Therefore, COPA intercepts the incoming and outgoing email traffic and passes it through the three layers described above. Fig. 1 shows the actual output of a COPA-processed email message, which is displayed to the user as soon as the processing is completed. In the following, this figure serves as an illustration of features of the four run-time components that are presented and explained subsequently.

*1) Detecting*

The first step along the execution of the process layer is the detecting component. Here, the COPA system uses the Enterprise Process Repository to determine whether the incoming email concerns an already running process or a new process instance has to be initiated. Based on a semantic analysis performed in the prior semantic layer (cf. [27] for more details), the email can either be assigned to an existing process—where it constitutes the next step—or the email is considered as a starting event and triggers a new process. In this case, a new process instance with its specific process ID (cf. Fig. 1, F) will be created outgoing from the corresponding reference model template from the Enterprise Process Repository. Further, the information whether the incoming email is part of an already instantiated process or a completely new one, is being displayed to the user (cf. Fig. 1, F). Future incoming emails concerning this particular process will be assigned to this initial process instance henceforth. As mentioned before, the correct assignment of the current process step to the correct template is being realized by an analysis of process characteristics done by the semantic layer. If the detection component assigns an incoming email to a wrong process (step) based on an incorrect semantic analysis, the user still has the possibility to manually reassign the email to another process step (cf. Fig. 1, H). To assist the user, the system provides information about the semantic matching of the email to a process step based on a percentage basis.

*2) Tracking*

As the second step along the process layer's execution, the tracking component monitors all incidents occurring within a running process and stores every performed step in context of the related process. This component utilizes the Enterprise Process Repository as well as the semantic information gathered from the original incoming email, to track which process is triggered by this email. Additionally, it updates the assigned process instance within the Enterprise Process Repository with all important data that can be useful or applicable for future process analysis. Each performed step concerns two occurrences, actions and events. Actions signify human or application triggered activities, whereas events on the other hand have no active part. In the context of email communication, actions mainly correspond to the activity of sending an email and events to incoming emails. Since every performed step is related to its unique process instance, it can be tracked and on this basis recommendations for further steps can be obtained and provided to the user (cf. Fig. 1, G). In case the COPA system is applied in a collaborative scenario, it may be possible that the incoming email belongs to an overall process, whose previous steps have been executed by other COPA instances. In this case, the tracking component offers a synchronization functionality, which offers the possibility of synchronizing already executed steps of an overall process throughout several COPA instances. Hereby, the tracking component determines which information has to be gathered from other known COPA instances. Thus, collected information will subsequently be added to the local database and utilized for further enhancement of the generated output. At this point other beneficial aspects of the tracking component and respectively the Commius project reveal. The gathered information provides a comprehensible documentation for further disposal.

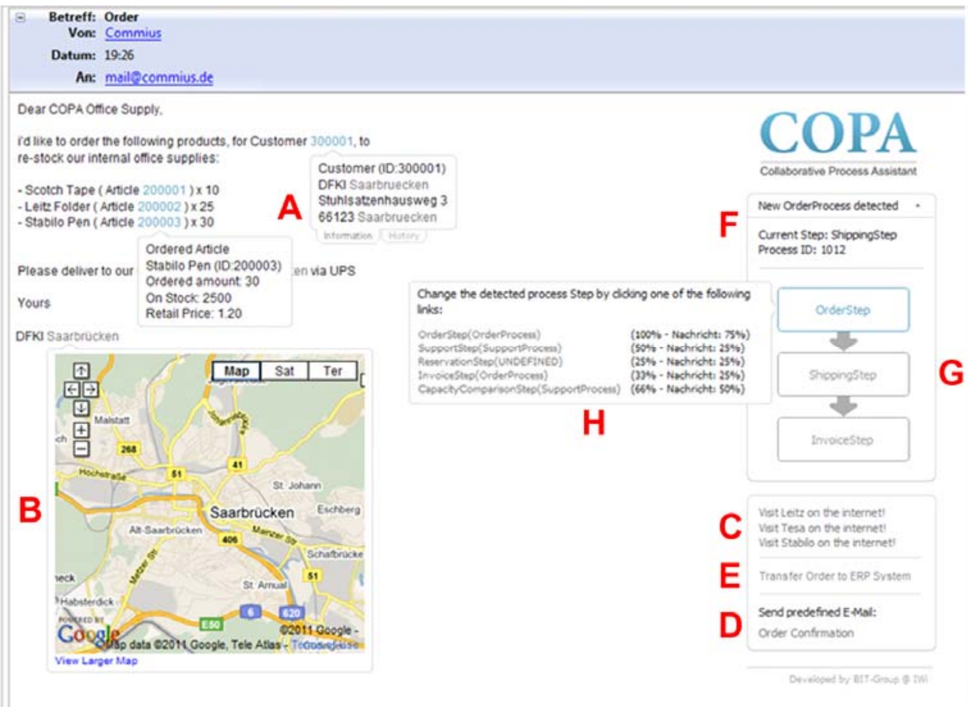


Fig. 1 A COPA-enriched email message

Due to the semantic extraction of process information, e.g. customer information and quantity of ordered goods, the system enables a (mostly) automated build-up of a company unique customer database. Moreover, the tracking component gives SMEs raise to business supporting functionalities only accessible by large scale enterprises. Gathered information, for example about the consumer behavior of customers, could be used by SMEs to send out individual offers to customers, to support other marketing activities, etc. The email contains two sets of data informing the user of the present state of the current process, as well as the visualization of the preceding process steps. The first data set contains key information about the email and the process at hand and informs the user about the present status of the process instance the email belongs to (cf. Fig. 1, G). The second data set shows an overview over all preceding steps in the current process including the corresponding emails.

*3) Assisting*

As the correct process step has already been identified by the detection component and the semantic layer, the assisting functionality is now deployed in two ways. First, the assisting component exploits the Enterprise Process Repository in order to gather relevant process data. Secondly, the assisting functionality supplies the user with case-related information about the particular process step. On the one hand, this datum consists out of internal information like customer history or article information from an own database (cf. Fig. 1, A). On the other hand, additional external information are offered context-based either in form of a gateway to useful web links (cf. Fig. 1, C) or email-integrated travel details to a location provided by Google Maps (cf. Fig. 1, B). Besides the context-sensitive enrichment of incoming emails with internal and external information, the assisting component provides the possibility to send email drafts that are context-sensitively selected and recommended to the user (cf. Fig. 1, D). Furthermore, if other software systems are used within the enterprise, e.g. ERP systems, components can be integrated that transfer information out of the email to these systems (cf. Fig. 1, E). Depending on the context, different information can be useful for a particular process. Hence, the type and level of detail of the information to be displayed can be adjusted using the customization tool (cf. subsection A).

*4) Advising*

Due to prior process instances and according user actions, there is already knowledge about the underlying process available, which forms the input for the advising functionality. Using the Enterprise Process Repository, the advising component—as the fourth step in the processing of an incoming email—offers suggestions and recommendations for the further proceedings in a particular process (cf. Fig. 1, G; for detailed information on the recommendation process, it is referred to [2]). A second functionality of the advising component is to provide advice in actually executing the next process step once the user has chosen one of the provided actions. This more interactive part is not directly invoked while processing an incoming email, but later via the embedded hyperlinks, which redirect the respective user to the COPA integrated web-interface where they will be provided with more specific information on the further proceedings.

## IV. THE EVALUATION OF THE PROTOTYPE COPA

### *A. Relevance of Evaluations within Design Science Research*

The information systems research is led by two oppositional paradigms, behavioral science and design science [12], [17]. Behavioral science, on the one hand, explains with theories the human and organizational interaction with information systems regarding the whole life cycle of information systems, i.e. starting with their design and ending with their use and management [12]. On the other hand, design science does not develop theories to explain the interrelation of information systems, but it develops new and innovative IT artifacts. This development is always motivated by existing problems (i.e. business-driven) that should be overcome by the creation of new artifacts [12], [29].

According to [16], design science artifacts can be classified into constructs, models, methods and instantiations (a detailed literature analysis on IT artifact types can be found in [20]). Constructs are the basis to describe a problem, e.g. modeling languages. Models describe problems or solutions of a given (business) situation and are formed by a set of constructs. Methods describe how a problem can be solved, i.e. they represent for example an algorithm. Each method is described by a language (construct) and represented by a model. Instantiations are concrete implementations of an artifact, i.e. for example a prototype, which should demonstrate the advantage of containing models and methods. Beside these outputs of the design science research, [16] also distinguish between two major activities within the design science research: build and evaluation. They stated that the building activity only shows the feasibility to construct an artifact. On the other hand, evaluating an artifact shows whether the underlying problem is effectively overcome by the constructed artifact and therewith any progress is achieved within the problem domain. Consequently, evaluations pursue to demonstrate the utility, quality, and efficacy of constructed artifacts [12].

Thus, a solely built IT artifact cannot be seen as a completed research result until it is not evaluated against the underlying problem domain [23]. To conduct an evaluation, there are lots of methods available. [12] provides an overview on evaluation methods within the design science paradigm. The listed methods are classified into five different types, namely observational, analytical, experimental, testing and descriptive methods. The empirical evaluation conducted within this paper focuses on an experimental evaluation based on a controlled experiment.

### *B. Evaluation Settings*

Driven by the design science paradigm (cf. subsection A), the COPA prototype had to be evaluated. The evaluation should prove whether the stated project goals, which are implemented in the COPA prototype, result in practical benefits. Based on the goals of an artifact evaluation (cf. subsection A)—utility, quality and efficacy—the evaluation was led by three hypotheses, which represent what was expected to occur:

- **$H_{A,1}$ (efficacy):** COPA makes a workflow significantly faster.
- **$H_{A,2}$ (utility):** COPA makes a workflow significantly easier.
- **$H_{A,3}$ (quality):** COPA guarantees a significantly higher satisfaction with the workflow result.

To prove these hypotheses, test persons had to operate an example workflow twice. In the course of this, one execution was supported by the COPA prototype while the other one had to be operated in a common way without any COPA support. After each completed workflow execution, the test persons rated their workflow execution regarding their satisfaction with the processing time, their sensed easiness of execution and their satisfaction with the result of the workflow. Beside these three subjectively measured variables, the processing time of each workflow execution was objectively measured and served consequently as an objective indicator. To avoid any influence of the test persons regarding their subjectively rated processing time, they were not informed about the actual measured time until the evaluation was completed.

The evaluation was conducted in laboratory settings as a controlled experiment [12], to realize a comparability of both workflow executions. Therewith, equal conditions for both workflow executions as well as among all subjects were realized. In fact, controlled experiments implicate the awareness of test persons that they work in laboratory settings and not in a real world scenario as it would be for instance in case or field studies [12]. Nevertheless, to have the required direct comparison of a test person's workflow execution, this way seemed to fit best to prove the hypotheses. An important parameter that could influence the measured processing time is the learning effect caused by operating the same workflow twice [1]. This means, a subject learned already various things from the first execution, e.g. the testing environment or the course of the workflow in more detail, which could bias the processing time in the second execution. Thus, if the evaluation would have been done in a way that the second workflow execution was constantly supported by COPA, the processing time might already be less in this second execution based on the fact that the test person was already more familiar with the workflow and not necessarily due to the support by COPA. This applies vice versa, i.e. gained experience in a first COPA supported execution could result in an equal processing time in the second non-COPA supported execution. Consequently, the sequence of the execution types (with COPA vs. without COPA) was swapped in an alternating manner. In more specific terms, this means that the first test person started without the support of COPA and did the subsequent execution with the support. On the other hand, test person two started their workflow execution with the support of COPA and operated the second execution without any support. This procedure was alternated in all following executions.

Beside the abstract settings of the evaluation, the evaluation workflow had to meet different requirements. First of all, the workflow had to be easily understandable by the test persons because compared to a real world scenario, people operating a workflow are usually familiar with it. Furthermore, the evaluation workflow needed to be feasible with and without COPA. Consequently, the test environment could not be based on various software systems, e.g. databases combined with specific systems like order systems.

Therefore, the usage of standard spreadsheets, in this case Microsoft Excel files, seemed to be realizable in the easiest way. Moreover, spreadsheets fit also best because they are still one of the most-used information medium in today's business [18], [21], especially within the software landscape of SMEs. Furthermore, using spreadsheets and standard email clients, test persons did not have to become familiar with special systems.

Within evaluations it is often difficult to find an adequate number of matching test persons willing to participate in evaluations of research results. The German Research Center of Artificial Intelligence is located on the Saarland University's campus and has good relations to the university's administration. Therefore, the conductors of this study exploited their close relationship to the Saarland University to recruit a sufficient study sample of test persons to conduct the evaluation. To meet the requirement mentioned above the test persons should be familiar with the workflow or at least with the subject of it, a university-related workflow in the context of the subjects' work was developed (cf. Fig. 2).

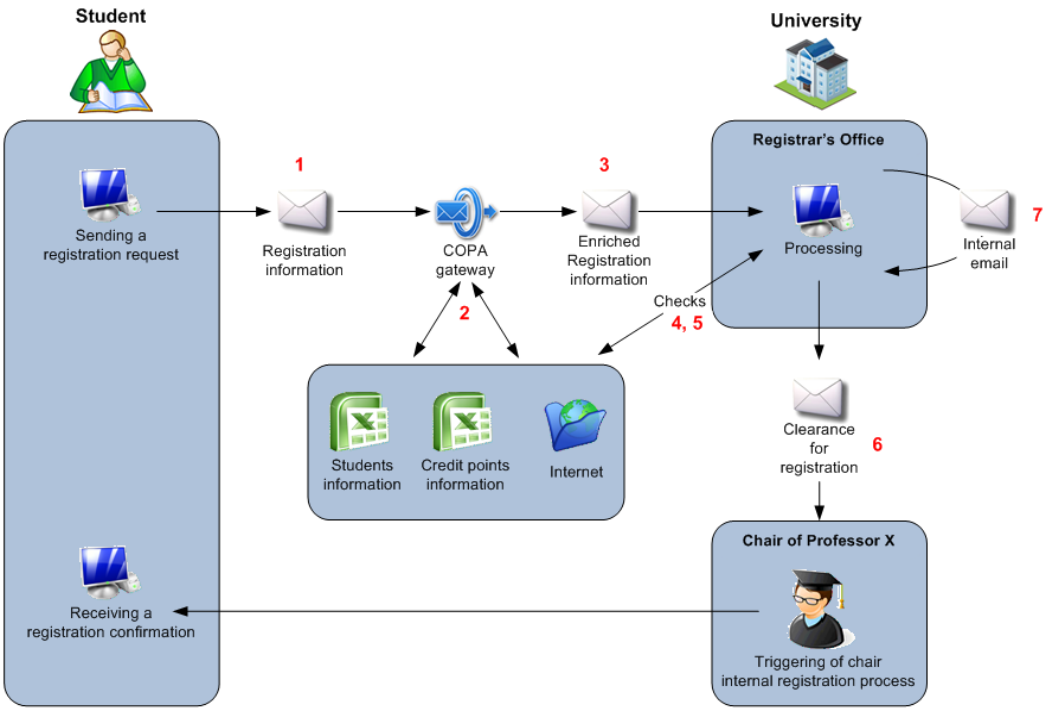


Fig. 2 The evaluation workflow

The evaluation workflow was about a student registration process for a seminar place. This process should be operated from the view of an employee at the registrar's office as the test persons were selected. The workflow was initiated by receiving an email from a student who requested for registering to a seminar place at the chair of his or her main subject. This plain text email message (cf. Fig. 2, 1) is automatically detected as a seminar registration workflow by the COPA prototype and is accordingly enriched with all required information to proceed with the workflow (cf. Fig. 2, 2). In more detail, these information are: the amount of achieved credit points in subject to register, a direct hyperlink to this chair's website for contact details and the overview on the further proceeding of the workflow (cf. Fig. 2, 3). The test person had to check now, whether the registration requirement (a minimum amount of credit points) was achieved by the student (cf. Fig. 2, 4). Within the COPA supported workflow execution, this check could be carried out very easily due to the fact that COPA had enriched the email with this information. Without the support of COPA, the test person had to look for the achieved credit points in a spreadsheet file that was provided in the testing environment. If the check was positive, the test person had to send an email to the correspondent contact person at the chair. To do this task, the email address of this person had to be searched on the chair's website (cf. Fig. 2, 5). Within the COPA-supported workflow execution, a direct hyperlink to the website was provided. In contrast, without COPA, the test person had to look for the contact website based on an internet search. This procedure should simulate the fact that the registrar's office is responsible for a huge amount of chairs and an employee always has to identify the correct contact person. After a successful search for the email address, the test person had to send an email to the chair saying the student had achieved the required amount of credit points and therefore a registration request could be accepted and was consequently forwarded to them (cf. Fig. 2, 6). In a last step, the test person had to send an internal email to their colleague informing them about the event and requesting for an internal data update (cf. Fig. 2, 7). Both emails which were sent by the test person triggered further workflows at the chair and the registrar's office. However, these workflows were not within the scope of this evaluation process.

This scenario shows various tasks that are typical for many business email communications. First, the intent of an email has to be identified. Secondly, further procedure within the workflow initiated by the email message must be known by the addressed person. Thirdly, different information retrievals have to take place based on which decisions are made. Fourthly, the workflow is continued by email communication with other persons that are responsible henceforth. Whereas traditionally, the person dealing with the workflow has to do these tasks manually in an error-prone and time-consuming way, COPA supports them in different ways. In this scenario, COPA automatically identifies the email as the first step in a registration process. Secondly, COPA provides an overview on the following steps within this workflow. Thirdly, the email is enriched with needed information out of different source systems and files. Fourthly, pre-defined emails are offered that fit in the workflow.

## V. Findings of the Evaluation

Technically, the evaluation was conducted with the statistical software IBM® SPSS® Statistics Version 19. The hypotheses were proved by conducting several statistical tests, all of which were based on a level of significance of $\alpha = 0.05$. However, due to space limitations, there will be no disquisition regarding proving the compliance of the conducted tests within this paper. Furthermore, various descriptive techniques were utilized.

Here is the study sample in a nutshell. The study sample had a size of n = 32 test persons. The sex distribution was almost one-third female and two-thirds male (cf. Fig. 3, left). The mean of the age distribution was quite young (26.63 years) and had a small standard deviation (SD) of 3.42 years (cf. Fig. 3, middle). In response to the question "How do you judge your IT-skills" (scaled from 1—"very good" to 5—"very poor"), 44 % judged their skills as "very good", 34 % as "good" and 22 % as "satisfactory". Based on a median of 2.00 ("good"), it can be assumed that the study sample had good skills in information technologies. Regarding experience with workflow systems, two-thirds of the test persons stated to have never worked with a workflow-based system before (cf. Fig. 3, right). Consequently, the study sample was not very familiar with workflow systems. Without any exception, all test persons stated to use emails as a means of communication "every day or almost every day". As a result, there seemed to be no major problems (e.g. in understanding the addressed topic of COPA) to evaluate COPA as an email-based workflow system based on this study sample.

### A. $H_{A,1}$: COPA Makes a Workflow Significantly Faster

The objectively measured processing time of the workflow execution types A (with COPA) and B (without COPA) (cf. subsection 1) as well as the subjectively rated satisfaction with the processing time (cf. Subsection 2) served as the basis to prove the stated hypothesis $H_{A,1}$.

#### 1) Objectively Measured Processing Time

The first step in this evaluation was to analyze the objectively measured processing time of each workflow execution. In case of a support by COPA (type A), the mean of the workflow executions was 134.22 seconds (sec) with a standard deviation (SD) of 49.20 sec. In contrast, the mean of the execution without a support by COPA (type B) was 186.97 sec with a SD of 54.98 sec (cf. Fig. 4). A dependent Student's t-test for paired samples showed a significantly faster processing of the workflow execution type A compared to type B. Therefore, as hypothesized in $H_{A,1}$, COPA made the workflow execution significantly faster.

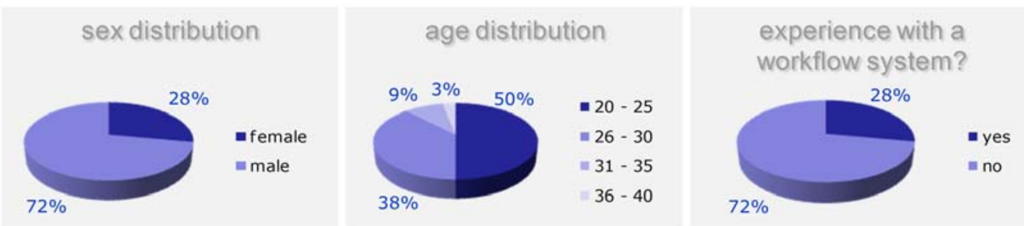


Fig. 3 Facts about the study sample

The mean for type A within the execution sequence type B -> type A was 106.73 sec with a SD of 35.48 sec. In contrast, the mean within the sequence type A -> type B was 162.63 sec with a SD of 45.76 sec. On the contrary, for type B, no significance was identifiable (mean 183.19 sec with SD 53.49 sec vs. mean 191.00 sec with SD 58.13 sec). This fact can be interpreted in the way that, within type A, there is still a margin in the processing time and this time will decrease in further workflow executions until it levels off. On the other hand, execution of type B can be seen as stable. Consequently, the fact that COPA makes a workflow faster is stronger the more experience a user have with a workflow.

As stated in the Section 3, the sequence of the process execution might have a significant influence on the processing time. This influence was tested in both types (A and B) of the workflow execution. Interestingly, for type A, the sequence had a significant influence on the processing time. Further factors that might influence the processing time—especially regarding working with COPA—are IT-skills in general and the experience with workflow systems. If these factors would influence the working with COPA in a way that less IT-skills or experience with workflow systems might result in a slower processing time, then COPA would rather be a system for professionals and not as stated in the project goals for any type of user in every type of SME industry.

However, a one-way analysis of variance (ANOVA) showed that less IT-skill resulted in a significantly higher processing time only in Type B of the workflow executions. In contrast, the processing time was significantly stable in Type A. Experience with workflow-based systems had a significant influence on the processing time neither in Type A nor in Type B. Consequently, COPA made the workflow significantly faster regardless of user’s IT-skills or workflow experience.

*2) Satisfaction with the Workflow Processing Time*

Beside the objectively measured time, which the test persons needed to proceed with the workflow, it is also important that test persons are subjectively more satisfied with their processing time.

This should be analyzed because it could be the fact that test persons operate a workflow faster with COPA, but however do not notice this decrease in time subjectively and sense the time due to a new working experience as even higher. Therefore, the subjects were also asked to rate their satisfaction with the processing time (scaled from 1—"very satisfied" to 5—"very dissatisfied"). Regarding a more valid result, it must be said that no test person was informed of their actual processing time before the entire evaluation was over. In Type A, more than the half (53 %) of the subjects expressed themselves as "very satisfied", 38 % were "satisfied" and less than 10 % were "neither" satisfied nor dissatisfied. On the contrary, in Type B, not a single test person was "very satisfied", 28 % were "satisfied", 38 % "neither", 31 % "dissatisfied" and 3 % even "very dissatisfied" (cf. Fig. 5).

A conducted Wilcoxon signed-rank test proved a significantly higher satisfaction with the processing time in Type A compared to Type B.

*B. HA,2: COPA Makes a Workflow Significantly Easier*

In contrast to $H_{A,1}$, the hypothesis "COPA makes a workflow significantly easier" could not be proved based on objectively measured variables. Therefore, this test of the hypothesis relied on the subjectively rated satisfaction of each test person, as it was in 2. The rating was scaled from 1—"very easy" to 5—"very difficult". Workflow executions of Type A were rated as "very easy" by 38 % of the test persons, more than the half (53 %) rated them as "easy" and less than 10 % as "neither" or "difficult". In contrast, in Type B, more than two-thirds (69 %) judged the easiness as "neither", 6 % even as "difficult" and only 25 % as "easy" (cf. Fig. 6). A conducted sign ranks test showed that the test persons judged the workflow execution significantly easier if it was supported by COMMIUS. Therefore, the hypothesis $H_{A,2}$ was accepted.

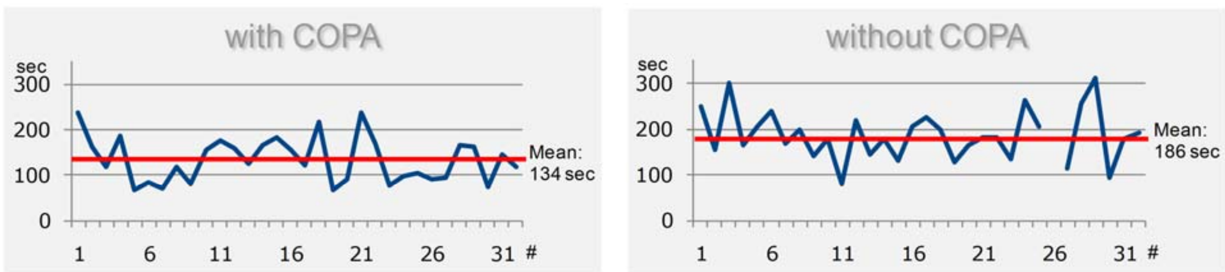


Fig. 4 Distribution of the workflow processing times

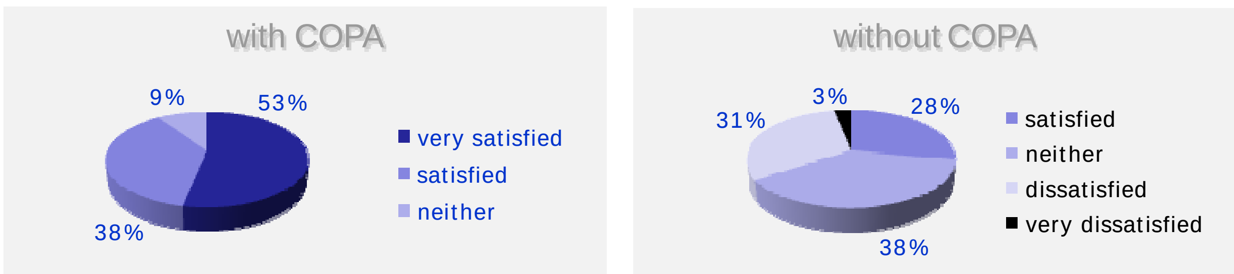


Fig. 5 Satisfaction with the processing time

### C. HA,3: COPA Guarantees a Significantly Higher Satisfaction with the Workflow Result

The last hypothesis that was tested within this evaluation is whether a significantly higher satisfaction—regarding the achieved workflow result—can be guaranteed by a COPA-supported workflow execution. A subject-based process error can be one reason for a negative workflow execution result—for example a workflow could not be operated successfully or not every step within a workflow execution could be operated without problems. The analysis was also based on subjectively measured variables that were scaled from 1—"very satisfied" to 5—"very dissatisfied". In Type A, almost half (47 %) of the subjects were "very satisfied" with their achieved workflow result and 44 % were still "satisfied", only 9 % expressed themselves as "neither" (3 %) or "dissatisfied" (6 %) with the result. Workflow executions of type B also resulted in "very satisfied" subjects (13 %) or even in more than half (53 %) of the cases in "satisfied" test persons.

However, more than one-third were "neither" or even less satisfied with their result (cf. Fig. 7). Beside some minor problems, one workflow execution of Type B stopped because of a self-inflicted process error by a test person (consequently a "very dissatisfied" satisfaction with the workflow result was expressed). In more detail, the subject came to the decision by mistake that the student, who requested for registering to a seminar place, had not achieved enough credit points for a successful registration. This decision was based on a wrong look up in the provided spreadsheet.

As a result, this showed the error-prone way of using such an information medium. On the contrary, within the executions of Type A, no process error took place. Thus, the practical benefit of an automatically enrichment of email message with information out of internal source systems could be shown. Moreover, a conducted sign rank test showed a significantly higher satisfaction with the workflow result, as hypothesized, if the test persons were supported in their work by COPA. As a result, the hypothesis $H_{A,3}$ was accepted.

### D. General Statements on COPA

Besides asking the test persons regarding their concretely operated workflow executions, they were also asked to rate statements on COPA in general, after they had done the practical part of the evaluation. Each statement could be rated on a scale from 1—"fully correct" to 5—"fully incorrect". The statements were partially based on the stated hypothesis and some goals of the COMMIUS project.

- S 1: COPA makes workflows easier.
- S 2: COPA makes workflows faster.
- S 3: COPA provides a clearly represented overview on the underlying workflow.
- S 4: Workflows are operated in a well-structured manner due to the allocation of emails to process steps by COPA.

The first statement S1 was judged as "fully correct" by 66 % of the test persons, 31 % rated it as "partially correct" and only 3 % were "indifferent". The results of the second statement S2 looked quite similar. Here, 69 % of the subjects judged the statement as "fully correct" and 31 % as "partially correct". The third statement S3 was judged as "fully correct" by 41 % of the test persons, 56 % judged it as "partially correct" and 3 % were "indifferent". The last statement S4 were "fully correct" rated by 53 % of the subjects, 44 % rated it as "partially correct" and 3 % were "indifferent". The strong agreements with statements S1 (median = "fully correct") and S2 (median = "fully correct"), which generalize the hypotheses $H_{A,1}$ and $H_{A,2}$, substantiated the results of the hypotheses tests within subsection A and B.

### E. Integration of COPA into Existing Email Infrastructures

The last analysis within this evaluation was related to the feature of COPA that it is seamlessly integrated into the existing email application infrastructures in a company. The test persons should rate this feature on a scale from 1—"very good" to 5—"very poor". The result was that 59 % of the subjects judged the integration as "very good" and 41 % as "good". Consequently, an integration of COPA into existing email landscapes is very widely accepted and rated as a very useful feature by the subjects.


Fig. 6 Easiness of the workflow execution

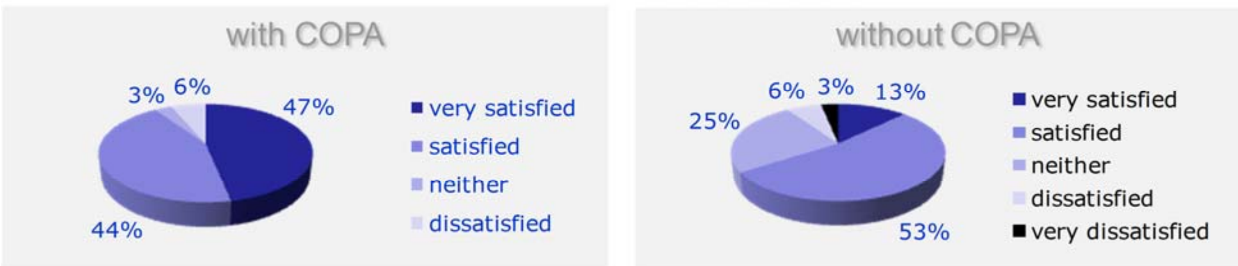


Fig. 7 Satisfaction with the workflow result

## VI. CONCLUSION AND OUTLOOK

The European research project Commius addresses the special needs of SMEs as well as the characteristics of email communication, namely high flexibility and lack of structure. Within the research project, the prototype COPA was developed as an email-based business process solution for SMEs. In the course of this paper, we presented an evaluation of this prototype. The evaluation was led by three hypotheses demonstrating the utility, quality, and efficacy of COPA in practice. All hypotheses could be verified due to the significantly faster and easier execution of the evaluation workflow and the higher satisfaction of the subjects regarding their achieved workflow result in contrast to a common non-COPA supported workflow execution. Furthermore, test persons agreed with general statements on COPA and judged the integration into the existing email landscape as a very useful feature. Consequently, COPA seems to be a feasible approach to manage email-based business processes. However, due to the broad range of industries in which SMEs are doing business, it is impossible to achieve a general applicable and representative result by executing just one evaluation. The laboratory settings in which the evaluation took place endangered this external validity additionally. The internal validity of the evaluation was quite high based on the same fact, though. This was e.g. achieved based on providing equal conditions for all subjects due to the controlled environment of the experiment. Furthermore, different influencing factors, e.g. the gained process experience based on the execution sequence which could bias the performance of the workflow execution time, were avoided for a high internal validity.

In a further step, COPA will be evaluated in a real-world scenario or even in a large-scale field study, getting away from a university-related background to a real SME business setting. Moreover, further features of COPA, which are only testable in a time-consuming way, e.g. the adaptive, flexible and self-learning features, will be evaluated. Nevertheless, this first evaluation has already shown the practical benefits of COPA based on real test persons. Thus, common users are able to work with COPA more efficiently in a less time-consuming and error-prone way as well as understand the features of it.

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