# The Impact of Activity Labeling Styles on Process Model Quality

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**Abstract:** Quality issues and their connection with structural aspects of process models have been recently studied, but there is still a notable lack of research into quality aspects of activity labels in business process models. In this paper, we investigate whether the guideline to use verb-object labels actually contributes to improved model quality in terms of less ambiguity and higher usefulness. In an explorative analysis of the activity labels in the SAP Reference Model we identify three labeling styles that differ in the degree of ambiguity they bring about. Based on these styles we design a survey to test the hypothetical connection between labeling style and quality. The results suggest that indeed the verb-object style is superior to other ways of constructing labels. Our findings are deemed to be useful for modeling practice.

Keywords: Business Process Modeling and ERP Systems, Conceptual Modelling, Evaluations of Systems Analysis and Design Modelling Methods and Techniques, Workflow Management

## 1 Introduction

Quality issues of conceptual models receive increasing attention in recent research since early design flaws tend to entail great mitigation costs in later design phases [Moo05]. Most work related to individual models aims to establish a connection between structural properties of a model (often called metrics) and quality attributes such as understanding, maintainability, and error-proneness [CGP+05, MRC07, MVD+08, GPP08]. This stream of research focuses on syntactical quality according to [KSJ06] since most of the metrics implicitly or explicitly build on assumptions about the cognitive burden to interpret the structural elements of a model. Yet the semantic and pragmatic quality of process models is hardly investigated. In this context, the choice of an appropriate text label has presumably a significant impact on the pragmatic quality of a model.

For business process modeling different authors suggest using a verb-object convention for labeling activities, e.g. [Mil61, SM01, MCH03]. In particular, the MIT process handbook

builds on an inheritance hierarchy of more specific verbs from the eight generic verbs *create, modify, preserve, destroy, combine, separate, decide,* and *manage*. These generic verbs have been identified using the lexical database WordNet [Mil95]. Beyond the popularity of this verb-object naming convention for activity labels, there is hardly any empirical support for this guideline.

In this paper, we address the lack of empirical insight on naming activities in process models in two ways. First, we use the sample of activity labels of the SAP reference model to discuss some issues of labeling. We gather a non-exhaustive list of potential problems and identify the lack of a verb as the presumably most serious issue. Second, we present the case of a process model that was created by a Dutch governmental agency that does not follow the verb-object convention in all its activity labels. We use this model in a survey asking students of a process modeling course at the Eindhoven University of Technology about their perceptions of ambiguity and usefulness of certain labels. The results show that a deviation from the verb-object rule is likely to decrease the clarity of the model.

Against this background, the rest of the paper is structured as follows. Section 2 investigates naming and interpretation issues of labels in the SAP reference model leading to two hypotheses on the connection between labeling styles and pragmatic quality aspects. Then, Section 3 describes our survey design and Section 4 the findings. Section 5 discusses the results in the light of related work, before Section 6 concludes the paper.

## 2 Activity Labels in the SAP Reference Model

In order to gain some initial insight into the issues related to labeling activities in business process models, we turn to the SAP Reference Model. The development of the SAP reference model started in 1992 and first models were presented at CEBIT'93 [KT98, p.VII]. Since then, it was developed further until version 4.6 of SAP R/3 which was released in 2000 [MADV06]. The SAP reference model includes 604 EPC business process models that have been analyzed regarding relaxed soundness and structural problems in other research [DVJVA07, MVD$^+$08].

Altogether, these 604 EPC models include 19,838 activity labels with 4,551 of them being unique. We manually classified all activities into three categories according to their labeling style: verb-object style, action-noun style, and a rest category. The high percentage of the verb-object style suggests that modelers prefer it due to its easy interpretation (see Table 1).

**Verb-Object Style** Starting an activity label with a verb followed by an object is the most popular style in the SAP Reference Model: 60% of all labels, i.e. 11,830 activities, follow this pattern. Most of these labels are intuitively understandable. Still, there are some cases that are ambiguous from an grammar point of view: the English language allows for a so-call *zero derivation* beyond the suffix *-ize* and the suffix *(i)fy* derivation of verbs from nouns [Dix08]. As a consequence, the same word can both be a noun and a verb. Consider, for example, the labels *Measure Processing*,

Table 1: Distribution of Activity Label Styles in the SAP Reference Model

| *Verb-Object Labels* | *Action-Noun Labels* | *Rest* |
|---|---|---|
| 60% | 34% | 6% |

*Export License Check*, and *Process Cost Planning*. They have in common that the first word can be a verb, but reading it as an object describing an action is also possible. *Measure Processing* could potentially refer to the processing of a measure or to the measurement of a processing. The same observation holds for the other labels. Some of these ambiguities can be resolved by considering context information like the labels of the other activities in the process. If the verb-object style was used as a standard, it would be clear to read the first word as a verb.

**Action-Noun Style** In 34% of the activity labels the action is grammatically captured as a noun. This noun can be either a gerund of the verb or a noun that is derived from a verb. While some labels following this style can be easily interpreted, there are more cases of grammatical ambiguity. Consider, for instance, *Notification Printing*. Again, there are two potential interpretations: a notification is printed, or someone is notified of a printing job. Alternatively, the verb could just have been forgotten by the modeler. This interpretation is likely in cases where the action noun could also be an object, like *order* which can be an action or an object. Therefore, the model reader might be tempted to infer the action by considering the context of the activity. Syntactically, the label could be easily extended with such semantically diverse verbs as *start*, *stop*, or *schedule*. Using a verb-object style avoids the problem of inferring a verb.

**Rest** There are 6% of the activity labels in the SAP reference model that neither include a verb nor a noun that refers to an action. Some of them clearly point to a business object, for instance *Status Analysis Cash Position*, such that a verb could potentially be inferred from the context. Yet there are also activity labels like *DEUEV* and *Jamsostek* that are difficult to understand at all. Presumably, the first one refers to the German regulation for data storage and transmission (DEÜV Datenerfassungs- und Übertragungsverordnung) and the second to the Indonesian social security system. The latter category requires crystal clear context information, otherwise an inference of the action is hardly possible.

In summary, we identified different classes of ambiguities that may occur for different labeling styles. For the verb-object style, we found only the narrow class of *zero-derivation ambiguity* in the SAP reference model. For the action-noun style, this problem class is relevant, too. Furthermore, this style might suffer from an *action-object ambiguity* if the action noun can also refer to an object. Finally, the rest group of labels that does not mention an action at all faces a *verb-inference ambiguity*. These three ambiguity classes differ in occurrence frequency: while the *zero-derivation ambiguity* requires the unlikely combination of a verb and an action object, the *action-object ambiguity* is found more often since many documents in a business context are synonymous to an action noun (e.g. *order*, *receipt*, *confirmation*). The *verb-inference ambiguity* is the most significant one, since all

labels of the rest group suffer from it. Following from this discussion, we identify two hypotheses related to the pragmatic quality of process models in terms of unambiguously facilitating action [KSJ06] and regarding usage issues [PS05].

**H1:** Verb-object style labels are less frequently perceived as being ambiguous, followed by action-noun style labels, and finally rest labels.

**H2:** Verb-object style labels are perceived as the most useful by process model readers, followed by action-noun style labels, and finally rest labels.

The next section describes our survey that is meant to tests these hypotheses.

## 3 Survey Design

For testing the hypotheses related to labeling styles we designed a survey asking about perceived ambiguity of certain activity labels and their perceived usefulness. In particular, we decided to present activity labels as part of a particular model for different reasons. First, a label in a business process model is never interpreted in isolation. Various other labels in the model and the control flow relationships establish a context against which a single label is interpreted. Since we aim to gain insight into labels in process models and not in isolation, we have to present all labels that are discussed in the survey in the context of a model. Second, we had to choose a model from practice; otherwise there would have been the risk that we (unconsciously) tailor it to meet our hypotheses. Third, this process model had to show a substantial variation in the labeling styles that are used.

Based on these considerations we chose a model of a complaint process from a department of a Dutch governmental agency (see Figure 1). The model follows the Event-driven Process Chains (EPC) notation, one of the most popular modeling techniques in industry. In an EPC, so-called *functions* (green rectangles) correspond to the various tasks that may need to be executed (e.g. "Register receipt date of complaint letter"). *Events* (red hexagons) describe the situation before and after a function is executed (e.g. "Customer at desk"). *Logical connectors* (grey circles) define routing rules. In particular, there are three types of connectors: the logical AND for concurrency, XOR for exclusive choices, and OR for inclusive choices. Functions, events, and connectors are the classical elements of control flow modeling. These routing elements are also included in other modeling languages like BPMN, YAWL, or UML Activity Diagrams.

The given model roughly describes the following procedure for handling complaints. A new case is opened if a new complaint is received – be it as a phone call, as a personal contact, or as a letter. In some situations, the complaint must be referred, either internally or externally. Internal referrals have to be put on the incident agenda while external referrals require a confirmation. In both cases the referral is archived in parallel. Finally, the complainant is informed. If no referral is required a complaint analysis is conducted. Later, the complaint is archived and the complainant is contacted, with an optional follow up.

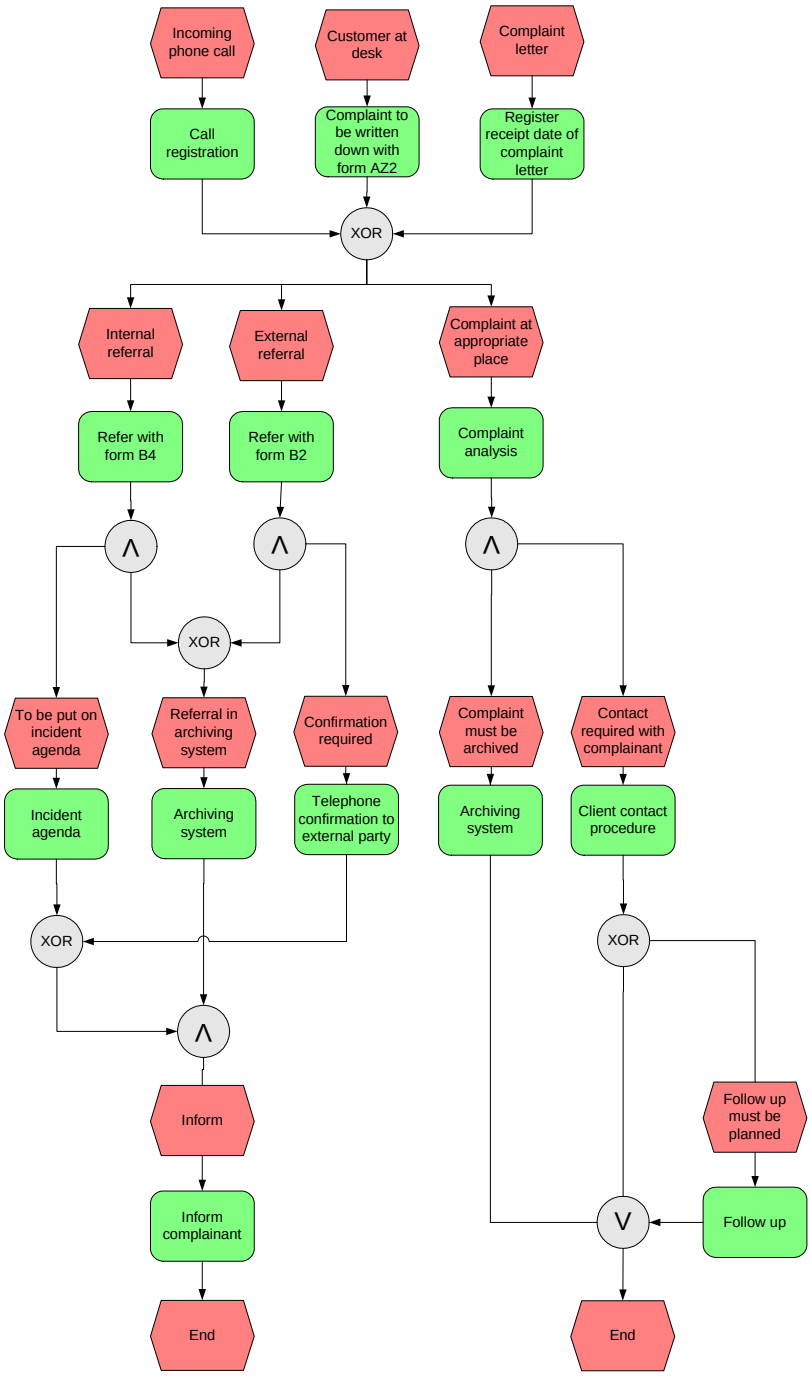


Figure 1: The original complaint process model

This complaint process model is at the heart of our survey. More in particular, the survey is subdivided into three parts. In the first part we record demographic information about the participants including gender, years of studying, preliminary knowledge of process modeling, EPC experience in months and number of created models, familiarity with EPCs, and preliminary knowledge of complaint handling processes. In the second part, shows the process model as depicted in Fig. 1. The participants are asked to identify those three activity labels that they consider to be the most ambiguous. In the third part, we adapt those two perceived usefulness scales from [MP07] that stress the act of understanding. These are *Overall, I found* [label] *useful for understanding the process modeled* and *Overall, I think* [label] *improves my performance when understanding the process modeled*. We ask the participants for their perception in these terms of six activity labels using a 7-point Likert scale. We chose two labels for each of the three styles we identified in Section 2: *register receipt date of complaint letter* and *inform complainant* as verb-object labels, *registration* and *follow up* that follow the action-noun style, as well as *archiving system* and *incident agenda* for the rest group.

## 4 Results

In this section we present the results of our survey. First, we summarize the demographics of the population of participants (Section 4.1). Then, we discuss the findings regarding the ambiguity hypothesis **H1** (Section 4.2). Finally, we turn to the usefulness hypothesis **H2** and analyze the respective results (Section 4.3).

### 4.1 Demographics

The questionnaire of our survey was filled out by 29 students who were at that time following a course on process modeling at the Eindhoven University of Technology. Participation was voluntarily, and as a reward we offered the students to send them a report of the results. 25 participants were male while 4 were female. While some of the participants only had followed university courses for one year, most of them had three years or more, with 3.8 being the mean value. Half of the population had preliminary experience with business process modeling, either from work or from following courses. Four persons had not yet worked with EPCs, but the average participant had known them for three months and had created 10 models. Altogether, 25 out of the 29 participants self-assessed their familiarity with EPCs as better than 3 on a 7-point Likert scale. We had had included a brief description of the EPC notation similar to [Men07, p.36] such that these participants should not have any disadvantage in answering the questions.

Table 2: Rank totals for the three label types

| *Verb-Object Labels* | *Action-Noun Labels* | *Rest* |
|---|---|---|
| 49 | 57 | 68 |

### 4.2 Ambiguity and Label Types

The second part of the survey focuses on the relationship between ambiguity and label types that is stated in hypothesis **H1**. We asked the participants to identify those three activity labels that they consider to be the most ambiguous. Since there are 12 distinct labels in the model and 29 participants, we received 348 assessments whether a particular label (belonging to a certain label type) was considered to be among the three most ambiguous. The labels *incident agenda*, *complaint analysis*, and *archiving system* were mentioned most frequently: 14, 13, and 12 times, respectively. Note that the first and the third belong to the rest group, while *complaint analysis* follows the action-noun style. The estimated probability of a label for being mentioned among the three most ambiguous was 0.13 for verb-object labels, 0.24 for action-noun labels, and 0.45 for the rest group. The 95% confidence intervals show little overlap: 0.08 to 0.19 for verb-object label, 0.17 to 0.31 for action-noun labels, and 0.32 to 0.58 for the rest.

We are interested in testing whether these differences are significant. The ANOVA test is not applicable, since variance is not homogeneous and because the dependent is not on scale level. Instead, we applied Friedman's two-way analysis of variance by ranks [Sie56]. For each correspondent, we ranked the three label types by considering for each type the proportion of its member labels being rated as most ambiguous. This gives us 29 matched evaluations, leading to rank totals for the three label types as shown in Table 2. As can be seen, verb object labels receive the lowest rank total, which means that this type is least often considered as containing ambiguous labels. The Friedman statistic $\chi_r^2$ can now be used to determine whether the differences are significant, because it is shown to be distributed approximately as chi square. For this case, $\chi_r^2 = 6.28$ with $df = 2$, which means that there is a significant difference at a 95% confidence level. From these results, we concluded that hypothesis **H1** is supported, i.e. indeed verb-object style labels are less frequently perceived as being ambiguous, followed by action-noun style labels, and finally rest labels.

### 4.3 Usefulness and Label Types

In the third part of the survey, we record the perceived usefulness of six activity labels, two for each label type. We use the two usefulness scales from [MP07] that relate to understanding, in particular, in how far the label is *useful for understanding* and *improves the performance when understanding*. For each of the two questions, we get 174 responses ($6 \times 29$) that we can link to label types. Based on this data, we discuss hypothesis **H2**. As the box-plots in Figures 2 and 3 illustrate, verb-object labels are perceived to be most

useful and performative, followed by action-noun labels, and the rest group. As Table 3 indicates, the 95% confidence intervals around the mean hardly overlap, and the verb-object style can be explicitly distinguished from the action-noun style in its perception.

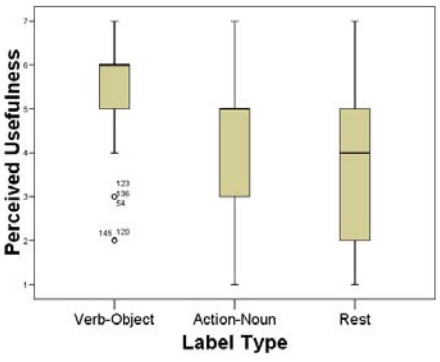


Figure 2: Perceived Usefulness of Label Types

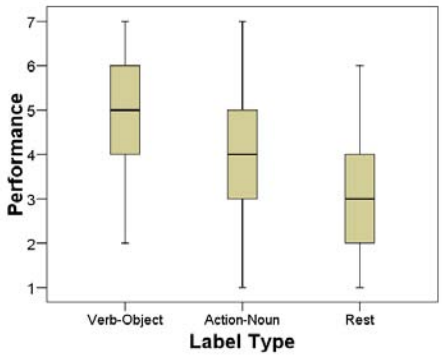


Figure 3: Perceived Performance of Label Types

Table 3: Perceived Usefulness and Performance of Label Types

| | | Perceived Usefulness | Performance |
|---|---|---|---|
| Verb-Object | 95% upper bound | 5.60 | 5.06 |
| | mean | 5.29 | 4.71 |
| | 95% lower bound | 4.98 | 4.35 |
| Action-Noun | 95% upper bound | 4.71 | 4.29 |
| | mean | 4.31 | 3.93 |
| | 95% lower bound | 3.92 | 3.58 |
| Rest | 95% upper bound | 4.12 | 3.77 |
| | mean | 3.69 | 3.41 |
| | 95% lower bound | 3.26 | 3.06 |

In the data we identified a significant negative rank correlation according to Spearman between the label style and its perceived usefulness (-0.417 at 99% significance level) and perceived performance (-0.367 at at 99% significance level). Both perceptions correlate with a Spearman rho of 0.749. This finding suggests that a deviation from the verb-object style is connected with lower usefulness and performance. Based on these analysis, we can conclude that verb-object style labels are indeed perceived as the most useful by process model readers, followed by action-noun style labels, and finally rest labels (**H2**).

## 5 Related Work

In this research we have found that deviating from a verb-object style for labeling activities in business process models is likely to result in a decrease of pragmatic quality of the model

in terms of ambiguity and usefulness. So far, there has not been any empirical investigation into label styles and pragmatic quality to which the findings could be compared. Yet there is an established body of knowledge in the area of modeling quality, verb classifications, and textual aspects of process models that this research complements.

Quality aspects of conceptual models have been discussed from various angles. Some research builds on semiotics and distinguishes syntactic, semantic, and pragmatic quality aspects of models [KSJ06] as well as criteria to measure them [PS05]. Our research mainly relates to semantic and pragmatic aspects of process models. We complement works that establish a connection between structural metrics and both understanding and error-probability [CGP+05, MRC07, MVD+08, GPP08] by investigating whether the verb-object labeling style might be superior to other styles. In contrast to previous works like [Mil61, SM01, MCH03] that recommend verb-object labels, we provide a sound empirical justification for this guideline.

So far activity labels of process models have been mainly researched from a conceptual perspective. The MIT process handbook discusses the difficulty of defining an inheritance hierarchy of actions. Building on the lexical database WordNet [Mil95] the authors define an inheritance hierarchy that originates from eight generic verbs (create, modify, preserve, destroy, combine, separate, decide, manage) [MCH03]. Verb classifications and verb ontologies have been proposed before. The systematic work by Levin is an important contribution in this area. It defines 49 semantic classes of verbs and categorizes more than 3,000 English verbs [Lev93]. In the meantime, this work has been extended in [KB04]. A formal approach towards a verb ontology is reported in [MG01].

Beyond that, the relationship between process models and natural language has been discussed and utilized in various works. In [FKM05] the authors investigate in how far the three steps of building a conceptual model, i.e. linguistic analysis, component mapping, and schema construction, can be automated using a model for predesign. A related approach is followed by [Gal01] who extracts knowledge from natural language sentences for building process models. Further text analysis approaches have been used to link activities in process models to document fragments [IGSR05] and to compare process models from a semantic perspective [EKO07]. These techniques could presumably benefit from an agreed-upon representation of activity labels using the verb-object style.

## 6 Conclusions

Motivated by a growing interest in quality aspects of process models, we have analyzed the connection between activity labeling styles and quality issues, such as ambiguity and perceived usefulness. In particular, we have explored labeling styles in the SAP Reference Model and found that labels can be categorized as verb-object, action-noun, and rest labels, with verb-object being the most frequently occurring one. Based on the cases of potential misinterpretations we hypothesized that verb-object labels might perform best from a quality perspective. Our survey could indeed confirm that (**H1**) verb-object style labels are less frequently perceived as being ambiguous, followed by action-noun style la-

bels, and finally rest labels, and that (**H2**) verb-object style labels are perceived as the most useful by process model readers, followed by action-noun style labels, and finally rest labels. These findings have strong implications for modeling practice. They suggest that the verb-object style should be used as a general guideline for modeling business processes.

In future research we aim to investigate which role verb classifications and verb ontologies can play in improving the quality of business process models. Some generic relationships between activities have been identified in [JP01]. For instance, a request should later be followed by a confirmation. The identification of a set of semantically non-overlapping, generic verbs and generic relationships among them seems very appealing for process modeling from a validation and a clarity perspective. Yet existing verb classifications like the one by Levin [Lev93] are not directly applicable for a business context: They include classes that are of little interest from a business perspective, but lack various specific verbs, for instance, from accounting. The verb hierarchy of the MIT process handbook might be a suitable starting point for this work [MCH03].

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