Agent Responsibility Framework for Digital Agents: Roles and Responsibilities Related to Facets of Work

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Abstract. This paper presents a new agent responsibility framework designed to help business professionals and IT experts collaborate around the analysis and design of digital agents. The framework emphasizes roles, responsibilities, and capabilities of digital agents in relation to work systems that they support. This paper presents basic concepts related to digital agents, work systems, and facets of work. It uses four examples to illustrate how the new agent responsibility framework helps in visualizing roles and responsibilities of digital agents in relation to work systems that delegate responsibilities to them.

Keywords: Digital agent · Work system · Facets of work · Agent responsibility framework

1 Toward a New Approach for Describing Digital Agents

Current trends toward digitization increase the need for analysis and design approaches that are suitable for business professionals because their appreciation of business and operational realities is essential for designing effective digital agents. That need frequently encounters longstanding difficulties in establishing effective and mutually supportive collaboration of business professionals and IT experts during the analysis and design of computerized systems. Aside from differences in professional interests and concerns, many aspects of this problem involve lack of fit between the interests and concerns of business professionals and the tools, methods, and concerns of IT experts. Many researchers have discussed related problems involving modeling method usage [1, 2], model comprehension [2–4], use of only a subset of the syntactic concepts provided [5], poor fit with modelers' aptitudes and knowledge [6, 7] excessive cognitive load [8], lack of flexibility, dilemmas of control, and excessive prescriptiveness [9]. Part of the problem is that widely used documentation tools and methods (e.g., BPMN and ERD) are often too detailed to support collaborative visualization and discussion related to system design and evaluation.

This paper follows the spirit of a 2018 *BISE* research note [10] that responded to the above issues by promoting ways to move enterprise modeling from an expert discipline toward "grass roots modeling" and "modeling for the masses" by accepting "softened

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requirements to completeness, coherence and rigor." This paper reflects that spirit while still calling for carefully defined concepts.

This paper's approach for articulating intuitive understandings of systems is largely separate from detailed documentation needed by development efforts. Its new agent responsibility (AR) framework was inspired by Shneiderman's human-centered AI (HCAI) framework [11–13], whose two dimensions are low to high computer automation and low to high human control. The AR framework's horizontal dimension is a spectrum of digital agent roles in relation to specific work systems. The vertical dimension is a series of facets of work to which digital agents might be applied in work systems. This paper explains those ideas and presents four examples to illustrate their potential use. Its emphasis on responsibilities of digital agents might facilitate analysis and design related to increasingly common digital agents even though it will not overcome all known problems related to requirements analysis.

Goal. This paper presents a new agent responsibility framework and explains how its use by business professionals and IT experts might facilitate analysis and design related to digital agents by helping them identify and discuss many types of roles and related responsibilities that work systems might delegate to digital agents.

Organization. This paper builds on a long research stream related to work systems. The next section presents a view of digital agents, which are a type of algorithmic agent. Work system theory (WST) is summarized as the core of a perspective for describing the usage context for digital agents. A hypothetical hiring work system illustrates how digital agents can be treated in designing or evaluating a work system. The agent responsibility (AR) framework is presented with emphasis on its two dimensions: a spectrum of roles and responsibilities and different facets of work. Each of those dimensions is explained in more depth through application to three additional examples of digital agents: an ecommerce platform, a real time advertising auction, and a self-driving car's information system. A concluding section summarizes the overall implication that the use of WST and the AR framework provide a practical approach for understanding and evaluating roles, responsibilities, and capabilities of digital agents in their context of use.

2 Digital Agents as Algorithmic Agents[1]

Digital agents are digital entities whose roles and responsibilities are delegated by work systems (defined later). They are algorithmic agents because they operate by executing algorithms. Those algorithms may be as simple as a decision rule or as complex as an advanced optimization method or an integrated algorithm for driving a self-driving car. Given their nature as abstractions, algorithms cannot do anything by themselves and have effect only when human or non-human actors use them to support, control, or perform actions in the world.

Table 1 lists examples involving digital agents that might or might not use AI-related capabilities. Some of them might be simple decision rules such as allowing no more than

[1] This section is an abbreviated and revised version of a section in [14] that discusses algorithms. A subsequent hiring example comes from the same source.

40% of applicants to be classified in category X. Even a simple algorithm like that one can have important and far reaching effects that favor one group of people over other groups, as when category X is treated as qualification for employment or acceptance into college. Digital agents that operate the internet or control autonomous vehicles are more complex and have more far-reaching impacts.

Table 1. Digital agents described based on the activities that they perform

• using facial images to identify people • converting spoken words into text • deciding which applicants should be hired or accepted by a university • deciding whether to alert medical staff about a change in a patient's condition • deciding whether a person is legally entitled to drive a car • deciding whether an autonomous vehicle needs to stop or swerve • controlling the aerodynamics of a rocket • translating from one language to another	• deciding whether to turn off a machine likely to have a mechanical failure soon • suggesting where police should be deployed over the next eight hours • selecting defective items that are being moved on a conveyor belt • combining multiple items in an order to minimize shipping cost • determining the best route for driving from a starting point to a destination • finding the laws that are most relevant to a specific lawsuit

3 Work Systems as the Context for Using Digital Agents

The work system perspective (WSP) is a general approach for understanding systems in organizations by treating those systems as work systems, as explained in [15, 16]. The WSP's core is work system theory (WST), which consists of the definition of work system plus two frameworks for understanding a work system: 1) The work system framework (Fig. 1) is a static view for summarizing how a work system operates. 2) The work system life cycle model (WSLC – Fig. 1) explains how a work system evolves through planned and unplanned change. Earlier confusion about the relationship between core of the work system approach and its various extensions was clarified when [16] identified WST as a conceptual core underlying the work system method (WSM) which had been developed over several decades as a semi-formal systems analysis method for business professionals. Various versions of WSM were tailored to instructional needs of different courses, most of which were for employed MBA and Executive MBA students. Individual students or teams of students used WSM templates to produce over 700 management briefings recommending improvements of problematic IT-reliant work systems during 2003–2017, mostly in their own organizations (e.g., [17]). The goal of a work system-based description or analysis is to understand a situation and often to communicate and collaborate about it with others. When describing and analyzing work systems, the identification and boundaries of the work system are choices that depend on the purpose of the analysis. As discussed in many articles and books about systems approaches (e.g., [18, 19]), different observers may use work system ideas to describe the same system (e.g., a sales system, purchasing system, or management system) somewhat differently

even when they pursue similar purposes. Parts of those efforts might document system components using rigorous tools such as BPMN and ERD, even though that level of specificity might be unncessary elsehwhere in those efforts.

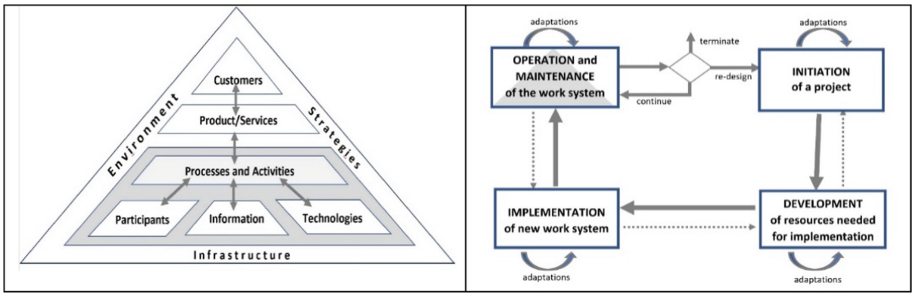

Fig. 1. Work system framework and work system life cycle model

Definition of Work System. A work system is a system in which human participants *and/or* machines perform work (processes and activities) using information, technology, and other resources to produce specific product/services for internal and/or external customers [16]. Terms in that definition are stated in relation to work systems rather than in relation to computer science or other discourses. C*ustomer* refers to any entity using the work system's outputs; *product/service* avoids distinctions between products and services that are not helpful when discussing work systems; *processes and activities* recognizes that activities in a work system may or may not be structured enough to call a process. The first *and/or* in the definition addresses trends toward service-orientation and automation by saying that work systems may be sociotechnical (human participants perform some of the work) or totally automated (machines perform all of the work).

Information Systems and Projects as Special Cases of Work Systems. Instead of seeing an IS as a tool, like a laptop or a hammer, the work system perspective treats information systems as work systems most of whose activities are devoted to capturing, transmitting, storing, retrieving, deleting, manipulating, and/or displaying information [15, 16]. An IS may be sociotechnical (e.g., financial analysts creating economic projections with the help of modeling software) or totally automated (e.g., computers generating economic projections automatically after being programmed by people). Projects are another important special case, i.e., work systems designed to produce specific product/services and then go out of existence. Software development is a type of project (and hence, a work system) that can be executed in many ways.

Digital Agents as Information Systems. Digital agents are totally automated information systems whose roles and related responsibilities are delegated by a work system. The roles describe activities that a digital agent executes for the work system. The responsibilities describe the expected level of performance regarding those activities. A digital agent's capabilities determine the extent to which the delegated roles and responsibilities are feasible. A digital agent may be an integral component of the work system or may

be completely separate from it, as in outsourcing of work. The somewhat similar idea of delegation to agentic IS artifacts is explained in [20], which discusses many concepts related to delegation, rights, and responsibilities.

Work System Framework: Elements of a Basic Understanding of a Work System. Figure 1 identifies nine elements of a basic understanding of a work system's form, function, and environment during a period when it retains its identity even as incremental changes may occur, such as minor process changes, personnel substitutions, or technology upgrades. *Processes and activities*, *participants, information*, and *technologies* are completely within the work system. *Customers* and *product/services* may be partially inside and partially outside because customers often participate in activities within a work system and because product/services take shape within a work system. *Environment, infrastructure*, and *strategies* are external to the work system even though they have direct impacts on its operation.

Work System Life Cycle Model (WSLC): How Work Systems Change Over Time. Figure 1 says that work systems (including digital agents, which are work systems since they are information systems) evolve through a combination of planned change via projects and unplanned change via adaptations and workarounds. Significant changes typically affect multiple elements of the work system framework, not just technology. Projects that pursue planned change in business settings traverse three main phases: initiation, development, and implementation. Many aspects of the WSLC remain valid even with nominally agile approaches. Those aspects include the emphasis on work system changes rather than just software development, the focus on evolution over time rather than one-time projects, the simultaneous importance of planned and unplanned change, and the relevance of key responsibilities within each phase.

3.1 A Hypothetical Work System that Uses AI-Based Digital Agents

Table 2 is a work system snapshot (a tool from WSM) summarizing a hypothetical hiring system that is used here to illustrate a work system perspective in a situation that might involve AI. In this example, PQR Corp implemented a new hiring work system two years ago to improve a previous hiring work system that absorbed too much effort inside PQR Corp and operated so slowly that qualified candidates sometimes took jobs at other companies before receiving offers. Also, it hired too many unsuitable candidates who left before becoming productive. The new hiring work system used AlgoComm and AlgoRank, digital agents controlled by software from a cloud-based suite of software tools provided by AlgoCorp. AlgoComm provides capabilities for posting job ads, receiving applications, setting up interview appointments, and performing other communication with candidates. AlgoRank ranks candidates based on job criteria and a machine learning application driven by AlgoCorp's extensive database of job qualifications, salaries, and other information. Both AlgoComm and AlgoRank are digital agents.

Management has become dissatisfied with the current hiring work system. Excessive effort and delays have been reduced, but interviewers and applicants find the AlgoComm interface mechanical, uninviting, and lacking a human feel. Also, three unsuitable hires

occurred in the last six months despite use of AlgoRank capabilities. Management wants to launch a new project to upgrade the hiring work system once again. This may involve eliminating the two digital agents, obtaining changes by AlgoCorp, or using either or both digital agents in different ways.

Table 2. Work system snapshot of the current hiring system

Customers	**Product/services**
• Applicants • Hiring manager • Larger organization • HR manager (who will use the applications to analyze the nature of applicants)	• Applications (which may be used for subsequent analysis) • Job offers • Rejection letters • Hiring of the applicant
Major activities and processes	
• **AlgoComm** publicizes the position. • **Applicants** submit resumes to **AlgoComm**. • **AlgoRank** selects shortlisted applicants and sends the list to the hiring manager. • **Hiring manager** decides who to interview. • **AlgoComm** sets up interviews.	• **Interviewers** perform interviews and provide comments about applicants. • **AlgoRank** evaluates candidates. • **Hiring manager** makes hiring decision. • **AlgoComm** notifies applicants. • **Applicant** accepts or rejects job offer.

Participants	**Information**		**Technology**
• Hiring manager • Applicants • Other employees who perform interviews	• Job requisition • Job description • Advertisements • Job applications • Cover letters • Applicant resumes	• Applicant short list • Information and impressions from the interviews • Job offers • Rejection letters	• AlgoComm • AlgoRank • Office software • Internet

A quick glance at Table 2 shows that the hiring work system involves much more than the digital agents AlgoComm and AlgoRank. The transition from the previous hiring system to the current hiring system started with a WSLC *initiation phase* (Fig. 1) in which management decided to improve the existing hiring system by using a vendor's software. The WSLC *development phase* acquired resources needed for implementation in the organization. AlgoCorp was selected as vendor. Developers initialized AlgoCorp's software, set values of parameters to fit PQR Corp's needs, and adapted AlgoCorp's training material for PQR Corp's users. Training during the *implementation phase* occurred quickly. During the *operation and maintenance phase* AlgoCorp used machine learning to update AlgoRank to reflect job market changes. Several incidents during that period involved managers working around the standard process (called *adaptations* by the WSLC) when talented individuals might have gone to a competitor. Management decided that a better hiring work system was needed.

This hypothetical hiring case was designed to illustrate how a work system perspective can help in visualizing and understanding applications of digital agents in real world practice. The main point is that digital agents that affect people typically operate in real

world contexts that are fundamentally about work systems achieving real world goals and are not about just about creating or using computerized artifacts.

4 Facets of Work

Facets of work is an extension of WST that supports a deeper understanding of roles and responsibilities of digital agents in work systems. That idea grew out of research trying to bring richer and more evocative concepts to systems analysis and design and to facilitate interactions between analysts and stakeholders, as explained in [21: 342–344]. The notion of facet is an analogy to how a cut diamond consists of a single thing with many facets. The idea of facet has been used with quite different meanings and connotations in disciplines such as psychology, library science, information science, and computer science (e.g., [22–27]).

Most activities in work systems consist of one or more common types of activities such as making decisions, communicating, and processing information. For current purposes, those types of activities can be considered *facets of work* if they are easily understood and widely applicable and if they satisfy a series of criteria: They apply to both sociotechnical work systems and totally automated work systems; they are associated with many concepts that are useful for analyzing system-related situations; they are associated with evaluation criteria and typical design trade-offs; they have sub-facets that can be discussed; they bring open-ended questions that are useful for starting conversations. Table 3 illustrates how the facet *decision making* satisfies those criteria. [21] identifies and provides the same type of information for 18 such facets of work, while recognizing that other researchers might have identified a different number of facets of work that satisfy those criteria. Facets of work often are not mutually independent. To the contrary, the facet *making decisions* often involves other facets such as *communicating*, *learning,* and *processing information.* The main point is that each facet can be viewed as part of a lens for thinking about where and how work systems might use digital agents.

Table 3. Why *making decisions* qualifies as one of 18 facets of work

Criterion	Illustration of how *making decisions* satisfies a criterion
Applies to socio-technical and totally automated systems	In a sociotechnical work system, marketing managers allocate a corporate advertising budget. In a totally automated work system, an optimization model allocates a corporate advertising budget
Association with many concepts that can be used for analysis	Decision, criteria, alternative, value, risk, payoff, utility, utility function, tradeoff, projection, optimum, satisficing vs. optimizing, heuristic, probability, distribution of results, risk aversion
Association with evaluation criteria	Actual decision outcomes, realism of projected outcomes, ease of implementation, riskiness, decision participation, concurrence

(*continued*)

Table 3. (*continued*)

Criterion	Illustration of how *making decisions* satisfies a criterion
Association with design tradeoffs	Quick response vs. superficiality, model complexity and precision vs. understandability, brevity vs. omission of important details
Existence of sub-facets for detailed description	Defining the problem; identifying decision criteria; gathering relevant information; analyzing the information; defining alternatives; selecting among alternatives; explaining the decision
Related open-ended questions	How do the available methods and information help in important decisions? What decisions are made with incomplete, inaccurate, or outdated methods or information? How might better methods or information help in making decisions? Where would that information come from?

5 The Agent Responsibility Framework

The hiring example summarized in Table 2 illustrates that digital agents can contribute to activities in work systems. That straightforward observation says little about how to understand roles of digital agents in greater depth. A designer or manager trying to decide whether or how to produce and apply a digital agent could benefit from a framework for identifying and visualizing potential design choices. As noted earlier, the agent responsibility (AR) framework in Fig. 2 was inspired by Shneiderman's 2 × 2 human-centered AI (HCAI) framework [11–13], whose dimensions are low to high computer automation and low to high human control. That framework is useful for discussing human-centered AI but can be expanded to support analysis and design of digital agents with responsibilities delegated by a work system.

The AR framework aims to serve that purpose by characterizing roles and related responsibilities delegated to digital agents by work systems. Clarity about those roles and responsibilities and the capabilities that make them practical requires attention to whether and how a digital agent aims to support specific facets of work in the work system, such as making decisions, communicating, or processing information. A work system's use of a digital agent occurs when that digital agent plays one or more roles (the framework's horizontal dimension) related to one or more of the work system's facets of work (the vertical dimension). The effectiveness of that use depends on the digital agent's capabilities. The brief description of the hiring example implied that roles played by digital agents included providing information and executing activities related to facets of work such as making decisions, communicating, and processing information but that enhanced capabilities might have led to better results.

Figure 2 is a version of the AR framework with six roles that might be performed in relation to any of six facets of work. Combining those two dimensions leads to pinpointing responsibilities delegated to digital agents by work systems. Other versions of the AR framework might include other roles and other facets of work.

Facet of work	Monitor work system	Provide information	Provide capabilities	Control activities	Coproduce activities	Execute activities
Making decisions						
Communicating						
Processing information						
Coordinating						
Creating value						
Maintaining security						
	<<<<<<< Spectrum of roles and responsibilities >>>>>>>					

Fig. 2. Agent responsibility framework with six roles and six facets of work

The AR framework presents the six roles along a spectrum from the lowest to the highest direct involvement in the execution of activities within a work system. The six roles in Fig. 2 were identified based on many iterations of trying to expand the horizontal dimension in Shneiderman's HCAI framework to make it more specific. For example, an early iteration involved only three roles, i.e., support, control, and perform. Here are ways in which those six roles might be performed more effectively in an improved version of the hiring work system.

- **Monitor a work system.** Digital agents might monitor hiring activities to identify important delays and might generate messages to management when aspects of a planned hiring process seem likely to use interviewer resources excessively.
- **Provide information.** Digital agents might scan applications to identify areas of important fit or misfit. Digital agents also might provide comparisons of current applicants with past applicants or even a relevant sample of non-applicants.
- **Provide capabilities.** Digital agents might provide analytical, visualization, and computational capabilities that help interviewers and managers compare applicants and articulate their impressions about how well applicants fit current needs.
- **Control activities.** Digital agents might inspect all informational artifacts generated by hiring activities to make sure that any evidence of bias, unnecessary delays, or mistreatment of applicants is identified and corrected quickly.
- **Coproduce activities.** Digital agents might coproduce with applicants by initiating and conducting screening interviews at times that maximize convenience for interviewees. They might work collaboratively with interviewers by filtering excerpts from voice and video responses that interviewers rate as important.
- **Execute activities.** Digital agents might search professional networks, listings from independent contracting firms, and applications from past applicants to identify potential candidates and send inquiries to those individuals.

The six facets in the vertical dimension are selected from 18 facets of work identified in [21], which showed that all or most of those 18 facets of work are worth considering

in many situations. The 12 other facets in [21] include learning, planning, improvising, interacting socially, providing service, and seven others.

Before saying more about the two dimensions in Fig. 2 it is worth noting that the AR framework encompasses ideas that can be used in many ways that do not rely on an exhaustive search of all possible combinations of roles and facets. Simply thinking about the different facets of work could encourage designers or managers to wonder about needs to enhance specific facets of work in the design of specific work systems. Similarly, the spectrum of roles in the horizontal dimension encourages designers or managers to consider different possible roles of digital agents, related responsibilities that might be assigned to them, and capabilities that would be required. There is no reason to consider all or even many of the 36 possible combinations of 6 facets of work and 6 types of roles/responsibilities (or of the 108 combinations based on 6 roles and 18 facets). Instead, practicality implies that designers and managers should look carefully only at the combinations that are important for a specific work system.

6 Application of the AR Framework to Examples

The hiring example in Table 2 was introduced to help in visualizing the relationship between digital agents and work systems. This section applies the AR framework to three other examples to illustrate its potential use in many situations from both provider and user viewpoints. 1) An ecommerce platform is a digital agent for a temporary work system in which an individual or organization uses an ecommerce platform to identify items to buy and complete the purchases. 2) A real time auction of ad placements in online media is a digital agent for a firm's advertising work system that purchases ad placements in online media. 3) The information system in a self-driving car is a digital agent for an individual's temporary work system of driving from one location to another.

The following descriptions of these examples include tables containing a row for each facet in Fig. 2. Each row shows in parenthesis one of the six roles in the AR framework's horizontal dimension and then summarizes how a digital agent playing that role might be applied to that row's facet of work. Table 4 applies the roles in the AR framework in the same sequence in which they appear in Fig. 2. Tables 5 and 6 (for two subsequent examples) use the same sequence but start with the second and third roles, respectively, as a partial illustration that most of the roles can be applied to most of the facets. Associating roles with facets in those different ways is significant only for illustrating that most roles apply to most facets. A more detailed exercise of assigning each role to all 18 facets from [21] would lead to tables containing 108 entries (6 roles $\times$ 18 facets) that would not fit within this paper's length limits.

6.1 Example: An Ecommerce Platform as a Digital Agent

This example is an ecommerce platform such as amazon.com or walmart.com that serves as a digital agent for an individual's temporary work system of selecting items to purchase and then purchasing those items. Table 4 shows how the six roles might be applied to the six facets of work in Fig. 2. Table 4 takes the viewpoint of an ecommerce merchant designing or updating a platform to maximize its utility.

Table 4. Applying different digital agent roles in an ecommerce example

Facet	**Illustration of how an ecommerce merchant might think about specific digital agent roles (*in parenthesis and italicized*) of an ecommerce platform in relation to a specific facet of work in a typical customer's personal purchasing work system**
Making decisions	(*monitor*) The digital agent might *monitor* interim decisions revealed in customer work system's click stream, thus providing clues related to customer goals and priorities and possibly leading to suggestions of plausible options that customers had not yet considered
Communicating	(*provide information*) The digital agent might *provide information* in the form of URLs that would help customer work systems communicate with other information sources that might validate purchasing decisions
Processing information	(*provide capabilities*) To demonstrate the ecommerce site's low prices, the digital agent might *provide capabilities* that customer work systems could use for processing information to find competitor's prices
Coordinating	(*control activities*) Coordination is not significant when an individual uses an ecommerce site. A digital agent might *control* aspects of coordination between multiple platform users in the same organization to avoid duplicative purchases within the same organization
Creating value	(*coproduce activities*) The digital agent might help in creating value for the platform and the customer by *coproducing* the identification of nonobvious buying opportunities that would increase mutual benefits
Maintaining security	(*execute activities*) The digital agent might help in maintaining security for ecommerce customers by *executing activities* that protect the security of email addresses, user names, and other personal information

6.2 Example: A Real Time Advertising Auction as a Digital Agent

A totally automated ecosystem controls the insertion of ads into web-based content such as online news articles. "It is a huge, real-time bidding process, whereby ads are automatically assigned to media spaces across types of media and geographic regions upon an individual user's browser request. … the entire ecosystem's exchange with its hundreds of platforms operates 'on-demand' every time a user's browser opens a publisher website and triggers a real-time request for an ad. The whole exchange is usually completed under 100 ms and remains entirely invisible to the user who may experience a small lag in loading the publisher page." [28]. The digital agent is a real time auction serving an advertiser's work system of buying ad placements in online media. (see Table 5).

Table 5. Applying different digital agent roles during in a real time auction for advertising slots

Facet	**Illustration of how a specific digital agent role (*in parenthesis and italicized*) of a real time automated auction might be applied to a specific facet of work in an advertising work system**
Making decisions	(*provide information*) The digital agent might *provide information* about past auctions that would support the buying work system's decision making concerning economically feasible media targets
Communicating	(*provide capabilities*) The digital agent might *provide capabilities* that increase convenience for the advertisers who need to communicate changing priorities and purchase limits as an auction proceeds
Processing information	(*control activities*) The digital agent might *control* aspects of the work system's processing of information about current priorities to assure that media choices are not excessively duplicative in advertising targets
Coordinating	(*coproduce activities*) The digital agent might help in *coproducing* advertising decisions of different groups in the firm by helping them coordinate priorities in data submitted to the online auction
Creating value	(*execute activities*) The digital agent might help in *creating value* for the customer work systems by providing more complete information about situations where other advertisers won auctions for prized placements
Maintaining security	(*monitor*) The digital agent might *monitor* bidding on auctions to help customers maintain security by identifying suspicious patterns of auction bidding results

6.3 Example: A Self-driving Car's Information System as a Digital Agent

Self-driving cars are controlled by internal information systems that combine radar, electronic maps, predictive techniques, advanced displays, monitoring of road and traffic conditions, monitoring of the car's internal operation, and automatic braking or swerving. Those information systems help drivers drive safely and sometimes allow drivers to use automatic driving capabilities. The work system is the individual's temporary work system of driving from one location to another. The digital agent is the car's information system that monitors current conditions, communicates with the driver, and takes control under some circumstances (see Table 6).

Table 6. Different digital agent roles for the information system that operates a self-driving car

Facet	**Illustration of how a specific digital agent role (*in parenthesis and italicized*) of a self-driving car's information system might be applied to a specific facet of work in a personal driving work system**
Making decisions	(*provide capabilities*) The digital agent might *provide capabilities* for making decisions related to avoiding bottlenecks or slow traffic
Communicating	(*control activities*) The digital agent might *control* aspects of the driver's communication with other drivers by activating blinkers, sounding alarms that help the driver and other drivers avoid accidents
Processing information	(*coproduce activities*) The digital agent might help *coproduce* partially manual driving by processing information from the steering mechanism and brakes to make sure that the driver does not accidentally perform dangerous maneuvers
Coordinating	(*execute activities*) The digital agent might automatically *execute* evasive maneuvers to help in coordinating with other self-driving cars that seem to be on a collision course with the car being driven
Creating value	(*monitor*) The digital agent might *monitor* the extent to which the car's displays, heating and air conditioning systems, seating adjustments, and other systems are creating value for the driver and passengers
Maintaining security	(*provide information*) The digital agent might *provide information* that helps in maintaining security by warning the driver that an outside entity is trying to detect electronic signals generated or used within the car

7 Discussion and Conclusions

This paper presented the agent responsibility framework and used examples to explain how it might help managers and designers imagine and evaluate a wide range of possibilities for delegating aspects of the operation of specific work systems to digital agents. It defined digital agent as a type of information system that operates autonomously once launched although it may interact with users, with other digital agents, or with aspects of the surrounding environment. The idea of digital agent may be applied by providers of digital agents (people or organizations that build and deploy digital agents) and by users of digital agents (people or work systems that assign responsibilities to digital agents that their organizations may own or to commercial platforms or other types of digital agents owned by others.

The core of this paper's contribution is the notion that work systems delegate responsibilities to digital agents and that those responsibilities involve performing one or more roles along a spectrum of roles that may apply to one or more facets of work in the work system. That notion leads to many different ways to visualize whether and how a digital agent might be applied beneficially and whether and how its capabilities might be improved to achieve greater benefits. This overall approach is designed to help in articulating a range of concerns that is much broader than the range of concerns uncovered by

widely used techniques such as use cases and user stories, which focus more on activities performed by IT users and less on the broader needs of work systems as goal-oriented systems. Similarly, tools such as BPMN and ERD are valuable for documenting details but tend not to reveal many issues related to facets of work such as making decisions, communicating, creating value, and so on.

The version of the AR framework presented here used a matrix of 6 roles × 6 facets of work. As explained earlier, many other facets of work could be considered if those facets of work were important for the work system being analyzed or designed. Those additional facets might be among the 18 identified by [21] or might be other facets of work identified by other researchers (assuming that those facets satisfied the usefulness criteria for facets of work that were illustrated in Table 3).

Limitations. This paper used examples to argue for the practicality of its approach for addressing important problems in real world practice. It did not provide empirical validation. Also, it did not provide a full literature review of requirements engineering or systems analysis and design. That type of literature review would have absorbed too much of the limited space available for explaining this paper's ideas.

Potential Use in Practice. Aspects of the AR framework can be used throughout projects that create and implement both work systems and digital agents used by work systems. Managers and executives can use the AR framework in the initiation phase of the WSLC (Fig. 1) to visualize many aspects of the application situation, e.g., by visualizing the relevant work system and exploring how new or improved digital agents might lead to more successful execution of different facets of work in that work system. In the development phase, developers can consider the extent to which the resources being developed are likely to contribute to better results for important facets of work. In the implementation phase, facets of work can be used to explain or discuss the responsibilities, capabilities, and intended use of digital agents that are being introduced or improved. The operation and maintenance phase can use the roles of digital agents in relation to facets of work to identify possible improvements that might generate better results in the future.

The detailed use of the AR framework and other ideas in this paper can unfold in many different ways that look at how digital agents may have responsibilities related to different roles and may touch multiple facets of work. A simple approach is just to focus on roles in general, i.e., consider the spectrum of roles in the horizontal dimension of the AR framework and think about whether those roles are played well in the work system, regardless of which facets of work are involved. Another simple approach is to focus on facets in a general sense by identifying facets of work that seem important for the work system and evaluate how well those facets of work are performed. In more detail, it is possible to look at responsibilities of a specific digital agent across the spectrum of roles or its responsibilities in relation to various facets of work that seem important. A more focused approach looks at a specific role and a specific facet of work and explores how well one or more digital agents satisfy their responsibilities in relation to that combination of role and facet of work.

All of the above can be done with the 6 × 6 version of the AR framework or with an expanded version that might involve more facets or more responsibilities that are not

included in Fig. 2. As noted in Sect. 4, [21] explained how 18 different facets of work meet the criteria for being considered a facet of work, even though it is impractical to look in depth at every imaginable facet in a real world analysis.

Potential Use in Research. The AR framework and related ideas lead to a variety of possibilities for research projects related to digital agents. Conceptual research could compare this paper's view of a work system's delegation of responsibilities to digital agents with the discussion of concepts related to delegation and rights and responsibilities of agentic IS artifacts in [20]. Interesting research topics for empirical study of projects related to the design and implementation of digital agents correspond directly to potential uses in practice: How do managers and executives conceive of digital agent capabilities during the initiation phase? How do developers think about the potential use of digital agent capabilities that they produce? What is the range and rationale of perceptions and beliefs by work system participants concerning roles, responsibilities, and capabilities of digital agent? In what ways do work system adaptations during ongoing operation reflect attention to different facets of work and the adequacy of both capabilities and responsibilities of digital agents?

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