"Do you trust me?" - The Outlook of Belief, Desire and Intention in the Fourth Industrial Revolution

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ABSTRACT

Trust has been a barrier towards technology implementation, despite the benefits that technology promises to provide humanity since the emergence of the Internet. Nevertheless, the technology facilitates the current situation when there is a need to work from home (WFH). WFH has become a new norm across borders due to the COVID-19 pandemic in 2020. Many organisations have opted to shift their operations to virtual environment instead of physically being at offices formally, temporarily or permanently in future. Business owners, managers and supervisors feel the needs to keep track of each subordinate's work progress and have used many tools available in the market for reporting and record keeping processes. It is believed that intelligent software agents with the belief-desire-intention (BDI) model could assist both parties – employers and employees – and at the same time reduce stress and the feeling of insecurity among employees by improving trust between both parties. This research looks into the possibility of embedding intelligent software agents into the work progress reporting system that is scattered within an organisation. Five organisations were investigated from the perspective of respondents at operational level, and a proposed Detect-Determine-Direct (3D) Framework for work progress reporting automation is presented. This framework is based on the BDI Model found implementable in intelligent software agents, hence bringing out the significance of automation in work progress reporting without relying on specific systems. The reporting automation at operational level that could reduce trust issues is deemed significant towards a positive impact on the overall supply chain in IR4.0, especially during the pandemic crisis.

Keywords: Intelligent software agent, BDI model, 3D framework, work progress reporting, humanity.

I INTRODUCTION

The Fourth Industrial Revolution (4IR) is expected to change the way we live, work and communicate, changing the things we value and the way we value them. We can see the changes in business models and employment trends, as well as in working and living environment. With the recent outbreak of COVID-19, it is observed that our life is digitally transformed to a new normal, coincidentally aligning to the 4IR initiatives. When the situation forces organisations to let go some of their employees due to the economic crisis, it seems that they have to rely on the digital capacity they have to survive and sustain the business.

In the Fourth Industrial Revolution (4IR), it is a surprise that trust is still an issue, especially at operational level, where middle management chooses to play a role in micro-managing the subordinates. Observing across organisations from few industries, the trend of reporting work progress to the management seems to differ, yet it is highly dependent on the trust given to the employees. In organisations where humanity is highly expected to be embedded in the system, the trust issue still exists.

Focusing on one aspect of 4IR is the human side of getting things done within the process from farm to fork, i.e. the whole supply chain. Human interaction is still significant in today's supply chain management. However, with the recent pandemic, a high reliance on the automation and Internet connection has brought the human interaction to be on a challenging side. The trust that we have in interacting with each other by personally facing each other during a completion of an important task has reduced to a rate less than the common trust we have, via emails and social applications.

The question in hand is: Can we still trust what is being communicated via online messages (e.g. emails, social applications)? In some domains, the new normal of working from home (WFH) has caused a question of trust among the managers and employers towards their employees. As a result, a more rigid reporting process is required at all levels in an organisation, in which employees have to declare the tasks they do every day, how many hours they have worked for each task, and the percentage of each task completion. In some organisations, the employees are required to send snapshots or some proof that the tasks have been done as declared to the supervising manager, as soon as the tasks are completed on the same day. This has brought to a

hike in distrust within an organisation despite the idea of having more trust-enabled environment when online platform is used.

Technology, on the other hand, has reached an advanced level that software bots could imitate human's communication when interacting with customers or even employees, depending on the system purpose it is programmed for. The advancement of artificial intelligence has proposed the concept that imitate real human when intelligent software agents are programmed with learning ability as well as having belief, desire and intention (BDI). It is observed that the concept of BDI can be used to oversee and monitor human integrity at work, as the software agents can be programmed to communicate with humans like humans. More important than that, software agents can take up some mundane tasks commonly performed by humans (Mohammed et al., 2019), to ease humans' work while reducing their stress in overwork due to critical situations like a pandemic and working from home. These two could significantly help build trust among humans, especially between employees and their managing supervisors.

This paper aims to conceptualise the adoption of software agents in an environment that could enable trust among its stakeholders, namely employees and their managing supervisors, for the realization of the Fourth Industrial Revolution (4IR). In achieving this aim, the objectives of this study are: to investigate the current situation of reporting task progress and completion at operational level; and to conceptualise a software agent BDI framework that takes in the aspect of humanity in its architecture.

II BDI MODEL AND 3D FRAMEWORK

Belief, Desire and Intention, or BDI, are the three capabilities of an intelligent software agent. Burr, Cristianini and Ladyman (2018) defined an intelligent software agent as "any program that can be described as having a model of its environment, which it uses to take actions that enable it to achieve its goals, while also acquiring further information that it can use to update the parameters of its model". In such cases, the environment mentioned here includes the behaviour of a human counterpart or user, and the agent's goals would depend on the actions performed by the interacting user. In this environment, the agent would obtain rewards based on its ability to influence the behaviour of the human user (Burr, Cristianini & Ladyman, 2018) and mediate the user's tasks efficiently according to the actual goal (Ismail & Ahmad, 2014). In one of the tasks assigned for agents to perform in previous research include "mediating the processes required for monitoring and reporting actions" (Mzahm, Ahmad & Tang, 2013), which supports the work of this paper.

The three mental attitudes or concepts that are part of the BDI model assignable to intelligent software agent for its functioning are as follows (Perez, 2019):

- ***Beliefs*** represent the environment characteristics of the agent's model as what is believed to be true. It is seen as informative component and it is updated accordingly as perceived from each action. Since it is perceived from agent's environment, the beliefs may be false.
- ***Desires*** represent the ideal state of the agent's environment, as they store the information of the goals to be achieved, with properties and costs associated with each goal. Desires motivate agents to reach their goals, just like in the human mind as they represent things to be accomplished in the future. Desires might not be realistic nor achievable, but can be mutually inclusive or exclusive.
- ***Intentions*** represent part of the desires that an agent takes as goals to be accomplished soon. In other words, intentions are considered the current action plan chosen to be performed. Nevertheless, intentions cannot go against the beliefs.

Based on the BDI concept, a model was designed according to the tasks mediated by software agents. Ismail and Ahmad (2014) found an emergence of a pattern of Detect-Determine-Direct (3D) when goals were defined for the agents in previous research. The main goal for an agent to "detect" is to identify a situation that meets the required criteria, the "determine" task of an agent is basically to decide on what to do based on the detected situation, and the purpose for an agent with "direct" task is to perform an action based on the decision made on what should be done. Since this concept of 3D was derived from deep analysis on BDI and personal knowledge management concept learnt from real human situations, it is deemed to be the most suitable as a potential technique to be adopted in this research.

There was an evolution on the 3D Framework for the past recent years. It started with the Prediction-Detection-Action (PDA) Framework that was adopted in smart classroom environment (Ismail & Ahmad, 2013). It was then evolved into a multi-agent Precaution-Detection-Action (PDA) Framework, in which the concept was adopted in fall detection at geriatric centers (Tang et al., 2017). In both situations of PDA Framework in 2013 and 2017, the detection is performed at sensor devices and the action is performed either in the form of reporting, alert, or physical action by a machine. Unlike them, the 3D Framework adopted in this study is reflected

on the detection performed on work processes within computer systems, whereas the "direct" is an action of reporting within the computer systems as well.

BDI architecture, on the other hand, was adopted in indoor social robots for the purpose to make it proactive in communicating with humans (Ujjwal & Chodorowski, 2019). This proves that the BDI architecture can be used to integrate or even embed humanity into a system environment.

III RESEARCH SETTINGS: INTERVIEW SURVEY

Apart from the literature analysis, this research takes up short interviews to gather the process of tasks implementation and reporting at operational level from various sources. The focus is not only on the work process but also on the humanity part relating to them.

An example of the interview excerpt is as shown in Figure 1. The case differs from one organisation to another, in which some would enforce full 8 hours working in office as soon as the Movement Control Order (MCO) is lifted up on 1 June 2020, whereas some provide flexibility in working hours in office. In most cases, it depends on the nature of the job or tasks performed by the employees, whether they need to be in office or not.

> In Case K (education sector), the MCO started from 18 March 2020, and midterm break was pushed earlier to that date for 2 weeks (instead of the usual one week). Classes started in April, with daily reporting via WhatsApp to supervisors. Daily data entry on tasks completion in spreadsheet started on 1 June2020 until 31 August 2020, because employees started to check in to office phase by phase. Non-academicians started to work fully 8 hours a day in office starting 15 June 2020. Option of working from home is given to academicians but limited to 2 days per week starting 1 July 2020. After 31 August 2020, all employees are expected to be fully working 8 hours a day in office, especially the academicians.

Figure 1. Sample excerpt of an interview.

Five respondents from five case organisations were interviewed with questions related to their daily reporting methods to their supervisors and management board, especially during the Movement Control Order (MCO). Due to critical situation during MCO, the reporting procedure became quite strict in some organisations especially at operational level. Some organisations enforced daily reporting on top of monthly reporting processes, whereas some adopted weekly formal reporting on top of informal daily reporting processes. In addition to that, the use of technology differs among the organisations, with most of them rely on more than one tool, e.g. case organisation Z (as shown in Table 1) uses Zoom, Skype and Slack for the same purpose of communication but for different group of people and type of communication, i.e. formal and informal. The results summary of interview data analysis is as shown in Table 1.

Table 1. Work Processes during MCO in Five Organisations.

Case	WFH Status	Reporting Frequency		
		Daily Basis	***Weekly Basis***	***Monthly Basis***
Case K	WFH reduced by phases until 31 Aug 2020	Daily check in [Mobile App with GPS]		Submit full daily report on monthly basis with total number of hours spent in a month [MS Excel Spreadsheet, Email, Shared Drive]
		Key in task or activity performed, number of hours, completion rate [MS Excel Spreadsheet]		During online monthly meeting, need to switch on the web camera and answer through microphone to proof attendance[MS Teams]
		Optional, take snapshot as proof of task recorded [Social Media]		
		Daily report in the first month of MCO [WhatsApp]		
		Daily check out [Mobile App]		
Case M	WFH ended 31 May 2020	Daily check in [Google form]		Submit full daily report on monthly basis for all tasks and activities together with screenshots [MS Excel, Email]
		Key in task or activity performed, platform used, content scope, from what time to what time, location [Google Sheet]		
		Screenshot online task done as proof		
		Submit daily report [Google Form, Email]		

		Daily check out [Google Form]		
Case T	WFH ended 1 Jun 2020	No clock in or out because of flexi hours		Monthly 3-hour meeting on issues and complains [MS Teams]
Case Z	Fully WFH until 31 Dec 2020, except certain departments, e.g. Operations	Morning call and team (10 members) catch up for 30 minutes, to discuss what was accomplished the day before, any challenges or issues, and plans for the day [Zoom]	Submit weekly report and share summary progress of the week (by all 5 sub-departments under 1 department for this case) [Google Sheet]	Monthly department meeting (25 members) [Zoom]
		All day long, communicate online on task related matters, more towards informal communication within internal members [Skype]	All other reports for others to refer to [Google Document, Google Drive]	
		If required, discussion with technical team [Slack]		
Case L	Daily check in [Mobile App]	Daily check in [Mobile App]		
		Since all tasks are constrained in office, there is nothing to report when WFH		

Table 1 shows that most organisation does not require weekly reporting since they already have daily and monthly reporting processes. It is believed that this requirement is depending on the initiative of the supervising managers, whether there is a need to have weekly reporting or not. Since employees are reachable daily via WhatsApp Group, the weekly reporting may not be necessary.

Case organisation Z requires weekly reporting, partly because the organisation is very structured hierarchically, and their work processes are well focused at all level, hence there is a need to have weekly reporting to ensure sustainability of the business processes.

On another hand, case organisations K and M experience heavy daily reporting processes over multiple mediums and tools, which cause mental stress to the employees, especially when proof of tasks performed is highly required, i.e. observed in Case M. Even though Case T is from the same industry as Case K and M, it is observed that the organisation is highly flexible, proving that the level of trust is higher in that organisation.

IV FINDINGS

Based on the interview data analysis, the concept of Detect-Determine-Direct (3D) Framework by Ismail and Ahmad (2014) is adopted to design the BDI automation on the work process reporting outlined in Table 1. An outline of how the 3D is implemented is as shown in Table 2.

Table 1. BDI Automation on Work Processes using the 3D Framework.

Task	Detect	Determine	Direct
Check in	Data on time, location and health (green, yellow or red)	Required tasks based on health status, whether to proceed to next, or skip all until next day	
Submit previous day report			Submission of the save information or file to the supervising manager, trigger employee for confirmation first
Perform task	Log data on various tools, e.g. Outlook, Teams, portal, etc.		
Task completion		Based on log data, trigger employee to confirm % of completion, should be more than previous record (if related) if not yet 100%	
Task duration		Based on log data, trigger employee to confirm number of hours task is performed, rounded to 30 minutes	
Pictures captured	New picture data	The link to current task progress (i.e. after time start or before time end of current task), trigger employee for confirmation on this link	
Save daily report after each task			The data to repository, trigger employee to confirm the tasks identified throughout the working hours
Check out	Data on time and location		
Submit previous week report		Total number of hours spent to tasks for the week	The saved information (daily files) on Monday morning to the supervising manager, trigger employee to confirm before submitting

Submit previous month report		Total number of hours spent on tasks for the month	The saved information (weekly files) in the morning of the first date of the month to the supervising manager, trigger employee to confirm before submitting

The summary of automated work progress reporting in Table 2 defines the tasks to be assigned to the intelligent software agents, which carry the belief, intention and desire to perform based on Detect, Determine and Drive domains. This is translated into a comprehensive illustration, as shown in Figure 2.

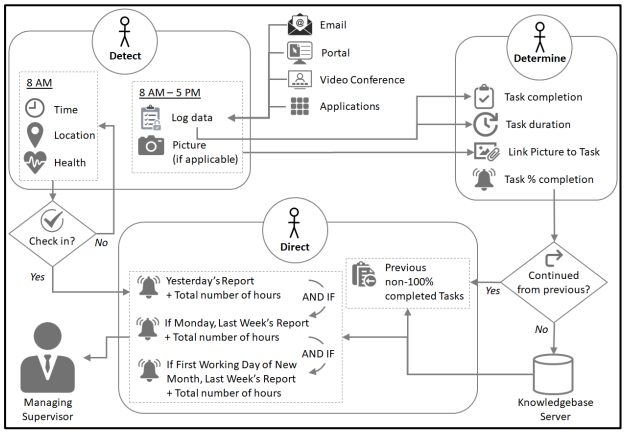

Figure 2. 3D Framework for work progress reporting automation.

Based on the illustration in Figure 2, there are three main agents performing the tasks in the agent environment, namely Detect agent, Determine agent, and Direct agent. These agents perform the tasks as how the names are given to them, and based on the summary of tasks in Table 2. The life of these agents is based on the daily routine of their human counterparts' activities. It is assumed that the agents are mobile and reside mostly in the computer system and network system of the organisation, and are able to move (if required) and perform tasks on the employees' computers, mobile devices and the servers possessed by the organisation.

The reason behind this architecture is to support the need of trust on the managing supervisors' side, as well as to reduce the feeling of intrusion and stress among the employees, which are triggered due to the strict reporting process. Nevertheless, the employees would not feel the rush or urgency to do the reporting tasks because the agents would do the compilation of their activities for them. The employees will only be triggered to confirm and verify whether the reports consolidated by the agents are correct or not, before being submitted to the managing supervisor.

V DISCUSSION

Figure 2 proves that the intelligent software agents can be designed to perform the consolidation and submission of reports, as part of their goals to mediate the tasks of their human counterparts. This supports the identification of mundane housekeeping functions that software agents could be deployed to perform (Ismail & Ahmad, 2011), and the need to adopt the BDI model to enable the agents to perform the tasks as illustrated in Figure 2. With the belief, desire and intention characteristics of the software agents, the system environment would be more comprehensive and doable.

From the illustration in Figure 2, it is found that there is a need to have some checkpoints in automating the reporting details. For example, after the detection of a person's check-in status (i.e. whether he/she applied for a leave), this system will decide whether to trigger the person to submit the progress report(s) or not. If the report(s) is not submitted at this point of time, the system needs to recall when the person checks in next. Not illustrated here is the checking of reports submission under Detect agent.

The complexity of agents' movement and tasks performance on systems outside of the human counterpart's computer (i.e. email server, portal server, video conferencing server, other applications servers) is not explained in detail here. It is assumed that the work performed by the humans will be initiated or triggered from their own computer or mobile devices. Hence, all processes related and extended from this point will be followed through by the software agents for detection.

With the belief, desire and intention functions embedded in the agents, they could identify what to be reported and what should not be reported. In this matter, there is a possibility of deploying another Control agent, to ensure that the humans' rights on privacy and confidentiality can be protected. It will also ensure security on the humans' and company's sides. Having said this, the Control agent should have its own BDI architecture and 3D framework. It is recommended that the future work will cover on this aspect.

VI CONCLUSION

COVID-19 pandemic has turned the table around with changes in organisational work process generally and how people do and deliver their tasks specifically. Business owners' intention on keeping track of their employees while working from home on daily basis reporting query via mobile application and communication software tools, like virtual conferencing software and such, has caused an increase of stress as additional workloads are added on employees' shoulders. Implementing intelligent

software agent within internal organisational network could reduce employees' burden on daily and monthly reporting, as well as enhancing trust among employers and employees.

This research started off with the issue of trust between the middle management and the operational level in various organisations. Taking the opportunity of humanity-enabled capabilities deemed possible in intelligent software agents called BDI Model, this research proposes the Detect-Determine-Direct (3D) Framework for work progress reporting automation, with a humble purpose to reduce trust issues (which was observed to deteriorate during the COVID-19 pandemic). Future work will look into the development of this multi-agent system with embedded BDI concept, which will benefit not only the operational level but will also give an impact to the whole supply chain in the Fourth Industrial Revolution (4IR). In other words, the overall outcome will be a bottom-up approach (Ismail & Ahmad, 2011) of work progress reporting automation.

In addition to that, there is an opportunity to look into the adjustable autonomy and its application (Mostafa, Ahmad & Mustapha, 2019) in this proposed multi-agent system to improve the automation of reporting process, as this could mitigate some of the challenges that come with developing autonomous system in dynamic environments. This is seen as an opportunity since adjustable autonomy management has been integrated within a BDI agent's architecture (Mostafa et al., 2017) in recent research.

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