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A Novel Approach of Modeling Levels of Automation of IT Services based on Bloom's Taxonomy

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ABSTRACT
Business process automation is certainly a highly strategic enabler of business control and agility. It is becoming essential to automate as many manual processes as possible when businesses need to perform increasingly complex and labour-intensive tasks. Technical developments in computer hardware and software make it possible to introduce automation at any stage of the process. This, IT service sector dominantly contributes to growth of businesses.
IT services are being used not only for creating, implementing, deploying and maintaining software applications but they exist in all areas of information technology. There are countless tailor made softwares created for automating business processes for small, medium and large scale industries. These applications can automate any of the functions in input, process and output model of a business process. Initially automation was applied to process part of IPO model for handling and processing data, so the computerization was the first step in automation of information processing. Later with machine learning and artificial intelligence algorithms it was extended to output functions for visualization and detailed reports. With the increase in such applications, businesses sought extending automation to even input function of IPO model. Manual data entry in software also became a candidate for automation and robotic process automation made it possible.
Levels of Automation were defined by many researchers for automation of control and information handling. These levels were ranging from 3 to 10 and were specific to application areas. However there has not been any literature on levels of automation for IT services. The concept of suggesting Levels of Automation for IT services is therefore a novel one. The objective of this paper is to explore the concept "Levels of Automation" (LoA) in IT service industry and to define LoA for IT services. A novel approach is taken for modelling Levels of Automation of IT services based on Blooms Taxonomy.
Key words: Automation, IT services, Blooms taxonomy.

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I INTRODUCTION

Automation is proving to be an invaluable asset to businesses though has huge impact on organizational traditions and it poses new challenges for the policy makers. IT services has been playing major part in the growth of business. IT industry is fuelling the growth of start-ups in India, and IT service sector has been contributing more than 50% of total IT exports consistently for last 5 years. The success of growth of IT industry is attributable to favourable government policies and healthy growth of related industries.

Let's take example of creating a software application for claims processing for a health insurance company for understanding increasing need of automation. The company receives the claims through emails which are opened by an employee. The employee extracts the relevant information from email and enters it in the application software manually and the required reports are generated through the software.

Initially the objective of creating such software for a company was to get accurate and timely reports. These reports can provide answers to questions such as how many customers registered for claims, how many were given compensation, which all were given compensation and to what extent, what is the percentage of customers who were benefitted, why some were rejected the compensation etc. All these reports were important for the managers for projecting success of claim settlement which could help them in getting more customers and in turn more business.

Later when the customer base increased, the no. of cases for settlements also increased and the managers observed the delay in claim

settlement. Investigation about the reasons suggested an opportunity for more and more automation in the existing software. With the changing programming paradigms from reusable components to artificial intelligence algorithms to robotic process automation and use of micro services, a new standard was set for automating business processes. Whenever automation was applied to any business process in any industry or any sector, levels of automation were defined for understanding the degree to which the task was automated. However, levels of automation for IT services have not been defined so far.

IT services can be availed for any business need and has potential to be used for any application of business. They are ever growing and generated as and when the need arises and hence they are open ended. In general, the business growth is directly proportional to the level of automation. Use of IT remains as underlined principle for automation for delivering timely accurate results, maintaining high quality in products and customer service. To understand levels of automation given the system capabilities, which processes can be automated and to what extent is the basic question. Technological advancements and the success of cloud computing have accelerated the evolution of business processes from re-engineering to automation.

II REVIEW OF LITERATURE

2.1 Automation

Automation in general is a technique of making a device, a process or a system to operate without human intervention. It creates easier ways to do business by using a wide range of IT services and machine-aided tasks to help improve productivity. Automation takes on different meanings based on context and situation. The term automation is used when we talk about business process automation, workflow automation, workload automation, tools automation etc. Also when we talk about information automation, the terms like acquisition automation, analysis automation, decision automation etc. are used. With the advances in technologies like robotics, IOT, machine learning and artificial intelligence, machines match or outperform human performance in providing services, including ones that require cognitive capabilities.

IT automation is the linking of disparate systems and software in such a way that they become self-acting or self-regulating [4]. IT automation can be understood as use of instructions or code to execute a repeated process that can replace an IT professional's manual work. For achieving automation in information technology industry, we use scripts, programs, macros, RPA etc. as against using mechanisms and robots in other industries. IT process automation (ITPA), is the ability to orchestrate and integrate tools, people and processes through workflow [1]. The goal of IT automation is to eventually demonstrate a strong ROI. There can be a fairly substantial investment on the front when deploying IT automation software, systems or infrastructure.

2.2 Levels of Automation

The degree to which a task is automated is referred to as levels of automation (LoA). Levels of automation range from complete human control i.e. manual to complete computer control i.e. fully automated. Work performed without any tool or support can be referred to as the complete human control whereas use of tools or other support to achieve the task can be taken as steps in increasing the level of automation. The levels of automation defined by many researchers were context specific. Some companies defined these levels as per their infrastructure capability for automation.

From literature review it is seen that the concept of "level of automation" (LoA) has been considered by many authors, but all were context specific and pertaining to specific application area. In general, a system can operate in either manual mode or in automatic mode but often the system is not fully automated. In paper [14] the author presented study of history of levels of automation in manufacturing and information processing. Sheridan and Verplanck first suggested ten-level taxonomy focused on human-computer decision making in the context of undersea teleoperation systems as given in fig.1.

Satchell, in 1998, suggested that sharing between humans and machines can occur in many ways, and level of automation can be decided based on the degree of human involvement. In 2003 Inagaki developed task allocation methods, introducing not only sharing but also trading of control. In 1997 Endsley proposed that there are five functions in a human-machine system that either human or an expert system can perform: suggest, concur, veto, decide, and act [14].

In 2001 Lorenz suggested that LoA in automated systems are differentiated based on not only the function but also on type of automation in information-processing stages. He suggested LoA could be seen through four stages of automation viz. Absence of Automation, Notification, Suggestion and Action [10]. In 1997 Billings indicated that the levels of automation are a division of tasks between the human and the automated system where the role of the operator can indicate LoA.

HIGH 10. The computer decides everything, acts autonomously, ignoring the human.

9. informs the human only if it, the computer, decides to

8. informs the human only if asked, or

7. executes automatically, then necessarily informs the human, and

6. allows the human a restricted time to veto before automatic execution, or

5. executes that suggestion if the human approves, or

4. suggests one alternative

3. narrows the selection down to a few, or

2. The computer offers a complete set of decision/action alternatives, or

LOW 1. The computer offers no assistance: human must take all decisions and actions.

Fig. 1: Levels of Automation of Decision and Action Selection

LoA in the context of telerobotics control was developed by Milgram in 1995. He defined LoA by considering the different roles a human operator can play in controlling telerobotics, including being a decision-maker and direct controller. In the context of teleoperations in 1995 Draper identified five different functions viz. programming, teaching, controlling, commanding and monitoring, are required to be carried out by the human. Draper discussed the level of control and how to combine human operators with machine control. Schwartz, in 1996, identified that there suggested six levels of automation in the context of teleoperations of satellites [14].

As suggested by Wickens and Hollands human information processing consists of four steps: acquire the information, analyze and display the information, decide action based on the analysis and finally implement the action based on the decision [14]. Parasuraman, Sheridan, and Wickens [12] introduced the idea of associating levels of automation to functions. They proposed a four-stage model of human information processing that includes: Sensory processing, Perception and/or working memory, Decision making and Response selection. These functions are based on above mentioned four stage model of information processing.

III. A NOVEL APPROACH TO DEFINE LOA FOR IT SERVICES

Levels of Automation were defined by many researchers for automation of control and information handling. There was a wide range of variation in levels from 3 to 10; since these levels were context specific. Moreover, LoA for IT services was missing in the reported literature.

A novel approach is proposed for defining Levels of Automation for IT services based on Blooms Taxonomy.

3.1 Analogy

Blooms taxonomy is a hierarchical representation of how to understand and remember a concept or any novel thing. It defines the relation between a tutor's frame of concept and his way of imparting the contents to his trainees. However, it is always not restricted to tutor trainee relation [8]. Hierarchy in Blooms taxonomy resembles the learning phases in the life of a human being. In the childhood at the age of 4 to 5 years all of us are taught to recite poems, shlokas etc. without being told its meaning. At that age we simply follow the instructions of our parents/elders obediently and remember what they teach us. That is when we are in 'Remembering' phase. Next we start going to school and we are exposed to different subjects broadly grouped under languages, mathematics, arts, social sciences etc. We start getting subject wise information. We require some guidance that makes us understand how the same information can have different meanings in different context. Here we enter 'Understanding' phase. Having gained some knowledge about formulae we start applying them to solve problems. e.g. we know compound interest formula and we can verify late payment charges applied to our electricity/ mobile bills or probably interest calculation of our loan repayment. This can resemble 'Application' phase. We are gradually heading towards higher phases of Bloom's taxonomy. As we grow we may start comparing our performance and effort with that of our friend's and can correlate reasons for the difference in the result. Unknowingly we have

entered 'Analyzing' phase. Later, when we are required to decide the discipline wherein we want to take up undergraduate studies, we gather information and compare its attributes for choosing the career path. We then start evaluating the pros and cons of each discipline on the basis of different attributes and arrive at conclusion. Here we dwell in 'Evaluating' phase. Our thoughts and actions are gradually changing as we mature in the process. Finally we become so experienced that we don't need structured way of tabulation and rules for filtering out unwanted information or for narrowing our choices and arriving at conclusion. We have now gained skills to work on unstructured input. We can create solutions to complex problems by building our own logic own logic of our own and thus we reach 'Creating' phase.

Using automation, IT services are also maturing in terms of design, implementation delivery and hence the same philosophy can be applied to level of automation of IT services.

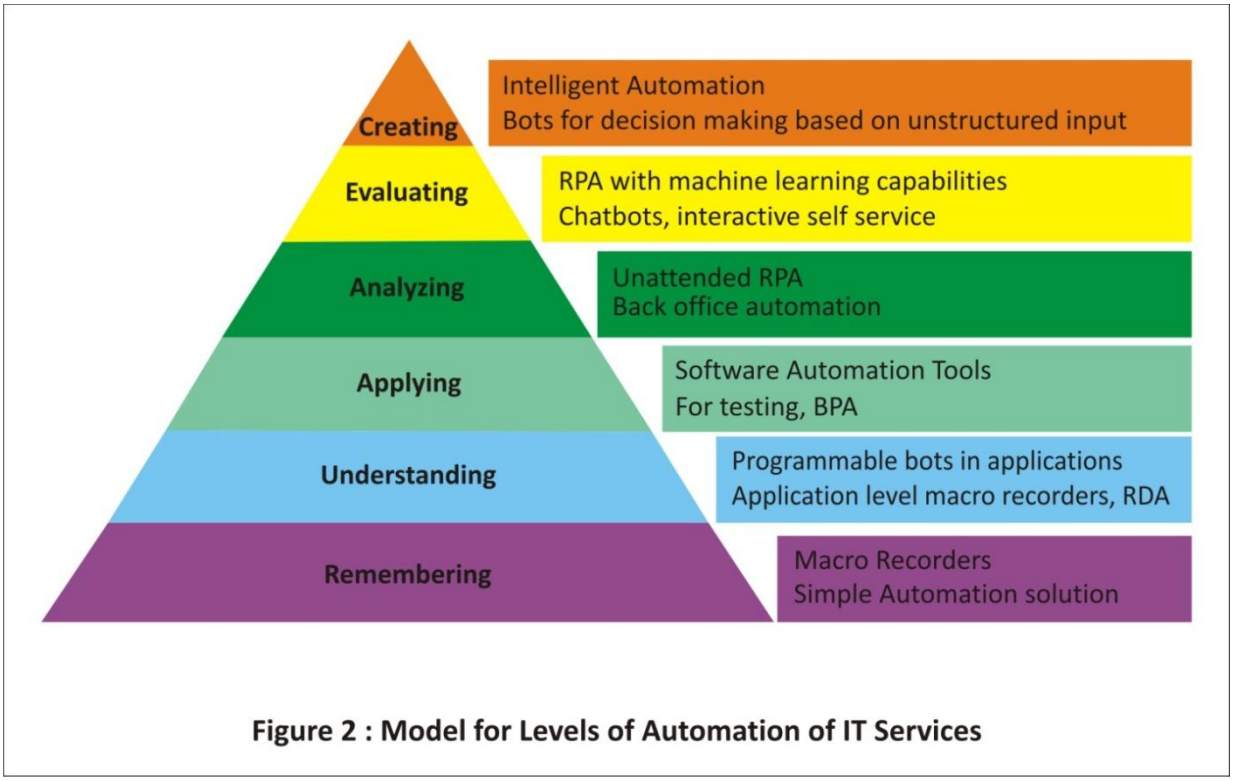

Figure 2 : Model for Levels of Automation of IT Services

3.2 A Novel Approach of Modelling Levels of Automation of IT Services based on Bloom's Taxonomy

Level 1 - Remembering : Macro Recorders

At this level we have considered simple automation solutions like macro recorders to automate basic processes. A macro recorder is a small code that records sequence of user actions of mouse or keyboard which can be played at later time. These are small programs that allow users to automate any activity in any software application. The activity could be as simple as copy-pasting data in a spreadsheet or little complex as some operating system maintenance actions. Macro recorders allow user to perform intricate operations with less effort and it gives without any complex programming it gives results much faster.

However, macro recorders do not attempt to analyze or interpret what the user did when the macro was recorded [7]. So while playing back a macro, it can cause problems and may not give desired results. If user has created a mouse macro with certain no of desktop icons or with certain desktop resolution and if the user has moved icons from desktop, or changed their desktop resolution, or moved the task bar etc. before playing the macro, macro will not give correct output. The keyboard macros are therefore preferred over the mouse-oriented macros.

Thus at the lowest level of IT service automation only those services that are provided with fixed sequence of steps without considering background environment in which the service is performed are considered as examples. Hence at this level no intelligence is expected of the automated service and only 'remembering' function is automated.

Level 2 - Understanding : Programmable bots in applications

At this level we have considered programmable bots which understand the context and operates within the context. The examples could be Robotic Desktop Automation (RDA), attended automation and macros at application level. RDA is like a virtual assistant that works hand-in-hand with human employees [6]. Before RPA, similar automations were implemented via scripts and macros but the scope was limited. The programmable bots are not restricted to single application just as excel automation. They understand the context and can interact with other systems so they are categorised in 'Understanding' level.

In attended automation, the bots can work alongside humans. It is helpful when it is difficult to automate the entire end-to-end process. Attended bots may operate under the direction of human team so they don't get triggered without human intervention. They take data from human worker and provide answers to their queries. They augment teams' workloads with automation, to help workflows run smoother. They are typically used for executing front-office activities.

For example, a call centre agent who is expected to attend customers' queries and solve them can take help from an attended bot during a live customer call. The attended bot can retrieve customer's data from one application and fill it into other application. As a result, the call centre agent need to spend less time in interacting with application and can spend more time in attending more customers. Attended bots are usually dedicated to one individual or one machine, and typically work while the employee is working. They are used in IT services that automate simple workflows with hard coded rules, menu based automation for data retrieval.

Level 3 - Applying : Software Automation Tools

At this level we have considered Software automation tools that are created by applying algorithms for specific purpose. The tools are used for software testing or quality assurance or for business process automation.

Business process automation tools make use of technology to achieve cost minimization, greater efficiency, and streamlined processes. It can also include software testing tools for functional testing or regression testing of software applications and network monitoring tools.

Level 4 - Analyzing : Unattended RPA

At this level we have considered automated solution with unattended RPA. These bots interact with applications without human intervention and execute tasks. Unattended bots can be scheduled and can be triggered by events. They can handle the tasks that can break down into step-by-step rules. Unattended bots take on processes from start to finish. Once set up, unattended bots operate in the background. They can be shared across many employees and can "work" 24 x 7 x 365.

For example, a general insurance company where large volumes of claims are required to be processed, or a store where large no of invoices are to be processed, unattended RPA can be used to automate events and actions within a workflow. They can also be used where a batch of client information is received in a spreadsheet and needs to be entered on multiple applications. Other examples include RPAs for email management, back office settlements, clearances, record maintenance, regulatory compliance, accounting etc. Use of unattended bots in these areas result into a streamlined data management process and documentation.

Just as when we analyze data to find meaning in data or when we analyze a process by conducting a review for understanding a processes, we actually review each component of a process, including inputs, outputs, data, procedures, technologies, applications, actors, controls etc., Unattended bots can be used for the tasks that can break down into step by step rules. Unattended bots can operate in background and analysis can be set to happen after sufficient information is collected.

Level 5 - Evaluating : Chatbots, RPA with machine learning capabilities

At this level we have considered RPA with machine learning capabilities used for Interactive self service. Chatbots interact with human customers by giving them the required information and evaluate their answers for resolving issues. These chatbots are deployed on websites, mobile apps, chat apps, social platforms and SMS service. RPAs that understand messages/problems of customers, use supervised machine learning and/or API Calls and solve the problem or even arrive at conclusion of handing over the tasks to human, can be categorised under this level.

Level 6 - Creating : Intelligent Automation

At this level we have considered automated solutions that use RPAs with unstructured or semi structured data to achieve intelligent automation. Intelligent automation is the combination of artificial intelligence and

automation used for making complex decisions faster. These systems can automate workflows or entire processes, learn from the input and build their own logic to form complete autonomous process.

For example, in invoice processing system suppliers send the electronic invoices by email. When a bot is used for downloading the invoice into a folder based on email subject and creating folder of invoices thro copy and paste action, it will be at 'understanding' level. But when we use AI to intelligently "read" the invoices, and extract the relevant information from the invoice such as invoice number, name of the supplier, invoice date, description of items, invoice amount and create a list of creditors then it will be at 'creating' level.

We are aware that different suppliers have different formats for invoice. Also the number of items billed in each invoice are varying. Since every activity in RPA needs to be explicitly programmed or scripted, it is practically impossible to teach the bot exactly from where to extract the relevant information for each invoiced received. There is need for AI to intelligently decipher the invoice just as a human would do, and hence it will be categorised at 'creating' level.

A marketing system that presents offers to customers based on their profile and market basket analysis, a credit card processing system that identifies and blocks fraudulent transactions and an e-discovery system that classifies documents according to their meaning and relevance to ongoing litigation can also be some examples at 'creating' level.

IV CONCLUSION

Levels of Automation were defined by many researchers for automation of control and information handling. These levels were context specific and there was a wide range of variation in levels of automation. Moreover, LoA for IT services was not there at all in the reported literature. Hence a novel approach is proposed here for defining Levels of Automation of IT services based on Blooms Taxonomy.

A code that can be used to execute the same task repeatedly is an example of preliminary stage of automation of IT service. Macros are used when same sequence of steps is required to be executed and they do not require knowledge of the context and surrounding environment. They are categorised in 'Remembering' level. As we automate more we can write scripts that understand the context and execute within the context. These services are categorised at 'Understanding' level. There are many tailor made programs that implement some algorithms for specific application. These are categorised in 'Applying' level. Unattended bots are categorised in 'Analyzing' level whereas the services that use artificial intelligence and can take decisions even from unstructured data are categorised at the highest level of Blooms taxonomy.

The services are bundled into products and they are sold in the name of products. e.g. Scheduled backup is a service offered by IT dept of a company. When it is done manually by some employee by running a command, it is accepted as a service. But when IT department automates it, they create a tool or a small app, and then it is looked upon as a product. Thus, in IT industry when IT services are automated, they are delivered as products.

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