

Studying Digital Literacy and AI Adoption in Software Engineering & Technology Companies

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Abstract—Traditional IT organizations and software companies are transitioning into digital service companies in order to survive in increasing competition. However, this transformation process is a major change requiring new digital skills, learning new methodologies and ways to work, introduction of new digital technologies as well as introducing new roles and responsibilities within the organization. In this study, we explore how skills, technologies, methods, ways to work and processes are changing in Finnish IT companies due to digital transformation. Our research focused on studying and promoting the adoption of Artificial Intelligence (AI) in IT organizations. The research problem of this study is: How traditional IT companies are approaching AI and advanced digital technologies? The main contribution of this paper is to show preliminary findings from an interview study.

Keywords—Digital literacy; Artificial Intelligence; digital transformation, software company.

I. INTRODUCTION

Digital transformation and uprise of advanced digital technologies (Artificial Intelligence, Extended Reality, Internet of Things, Digital Twins) affect not only non-ICT organizations but also ICT companies and software development units. Very likely, most IT companies use at the moment combinations of a software engineering approach (software development, project management and maintenance activities) and a service engineering approach (service design and engineering, cloud engineering, agile service development, service management). However, the role of service engineering is becoming stronger all the time and service management is altering many of the software maintenance activities.

IT companies are continuously updating and modernizing their key operational processes, such as software release management [1] to service release and configuration management [2], changing the scope of IT architecture from software architectures to enterprise architectures [3] and extending software quality-focused processes, for example, software defect management and failure management [4] to have wider approach (service incident management [5]) that also covers incidents due to poorly implemented processes, knowledge gaps of employees and failures made by third party service providers and seeks permanent solutions by investigating the root cause of service failures with problem management procedures [6].

Additionally, when a software development organization grows and complexity of service provision increases, the toolset of the organization also changes and evolves. For

example, most software development companies provide bug tracking systems (Jira and open source ticket systems) and problem solving communities for their customers since they start operating as a company. When a company decides to start operating in a service business, their toolset shall be expanded and very likely shall include an IT service management tool.

The business growth and digital transformation have a significant impact on organizational structures of software development. Most of Finnish IT companies are very small entities. This means that their development and support teams are small, have relatively limited resources and a richer set of responsibilities compared to those employees of large IT service provider organizations where service design, service transition, service operation, and continual service improvement are typically provided with different resources but certain level of systematic overlapping can be identified.

In a mature service organization, development teams are responsible for Early Life Support (ELS) [7] of new services for a certain time period. After that customer service and support are provided by service desk units that may evolve and mature into omnichannel service centers [8]. The key difference between a multichannel and omnichannel approaches is how integration between customer communication channels has been implemented. The omnichannel approach often involves usage of integrated environment for modern customer experience (CX) and well-integrated communication channels [9].

In addition to structuring organizational resources, companies need to pay attention to competencies required by the digital era. Every employee in the company should understand his/her role during and after the digital transformation process as well as understand the opportunities of digital technologies for the company's business. This is called in general digital literacy [10]. For a software development organization, the transformation might mean that there is less need for traditional Java developers, business analysts creating Unified Modeling Language (UML) diagrams [11] and business case documents [12] and project managers using waterfall and Rational Unified Process approaches; and more need for cloud service specialists, service design engineers and Agile project specialists.

Concerning digital literacy, governments world-wide are investing hundreds of millions for increasing competences of artificial intelligence, such as conversational AI [13], Machine Learning, Machine Vision, predictive analytics and other forms of artificial intelligence. Well-defined AI Application

Programming Interfaces (AI APIs) enable software developers to utilize latest AI functions in their software code without investing huge efforts in creating those functionalities in-house. The large scale use of APIs and related business models and practices together form the basis of API economy [14]. Software companies could use AI not only in information systems they provide to customers but also improve their own processes such as use Machine Learning in defect management to predict defects [15]. Additionally, machine learning could assist project management and project portfolio management to [16] in making better decisions or predict project success.

The goal of the Digital Innovation Hub (DIH) is to act as a one-stop shop that helps companies of the region in tackling digital challenges (our focus is on AI, HPC, data analytics and digital transformation). This study supports directly the objectives of the DIH by producing new knowledge on AI-powered digital transformation in Finnish companies and the status and targets of AI adoption as well as usage of other digital technologies (cloud, digital service management platforms) in service operation.

In this paper, we aim at answering the research problem: How traditional IT companies are approaching AI and advanced digital technologies? The main contribution of this paper is to study

- How evolution of AI and digital literacy skills is supported by software development/ICT organizations' managers?
- How AI and related technologies are used in software development/ICT organizations?
- How AI affects the daily business operations of a software development/ICT organization?
- How AI is linked to software development/ICT organizations' productivity?

This paper aims at providing research communities of software engineering and service science new knowledge on how managers support increasing AI capabilities related digital technology competences within their organizations.

The results of this study might be useful for digital transformation managers, development managers of SMEs, project managers of the projects where digital technologies are applied as well as HR managers for identifying what digital skills might be needed in IT companies in the future. The remainder of the paper is organized as follows. In Section 2, we present the research methodology of this study. In Section 3, main findings of the interview study are presented. Section 4 is the analysis part of our study. Finally, the conclusions are given in Section 5.

II. RESEARCH PROBLEM & METHODOLOGY

The research problem of this study is: How traditional IT companies are approaching AI and advanced digital technologies? We selected the research problem because both companies and government (ministries, regional, national and international funding agencies) in Finland are pushing more and more resources for transforming traditional production methods with artificial intelligence. However, small and medium

sized companies seem need a lot of help in introduction of these technologies and integrating AI components to their products and services.

The research problem was divided into the following research questions:

- 1) How evolution of AI & digital literacy skills is supported by software development/ICT organizations' managers?
- 2) How AI and related technologies are used in software development/ICT organizations?
- 3) How AI affects the daily business operations of a software development / ICT organization?
- 4) How AI is linked to software development/ICT organizations' productivity?

The first research question highlights the management support for digital transformation initiatives and our aim was to receive information that demonstrates the management support for AI projects and increasing competences of AI. The second research question was created to identify popular technologies and services that organizations use in their AI initiatives. This information might give non-AI companies a list of potential starting points for their AI journeys. With the third research question, we wanted to explore the impacts (both short term and long term) of AI programmes and finally the fourth research question aimed at generating a view to what types of benefits AI would result in the organization's productivity.

A. Data Collection Methods

The paper writing, selection of research methodology and analysis were performed at CEMIS research centre. However, empirical data for this study was collected during Digital and Intelligent Management of Service Operation project (ESF ELY) from 8 interviewees and their organizations represented various business domains in service provision such as ICT, energy, miscellaneous services, marketing and advertisement. Interviewees were selected for this study by using convenience sampling, however, we tried to achieve a rich, balanced set of interviewees with varying work positions, including management and governance (CEOs, senior management), product owners and product managers, customer service employees, service managers and designers. The questionnaire included both structured and open-ended interview questions. Due to COVID-19, most of interviews (1 hour) were conducted by using Microsoft Teams video conferencing tool and interviewees were provided an option to receive questions before the actual interview event by email.

B. Data Analysis

The data of this interview study were analyzed using a thematic content analysis technique that focuses on identifying common themes while searching the materials organically. The main objective in the analysis is to find common patterns across the data set. For video interviews conducted with Microsoft Teams, we used the recording function of Teams to capture entire interview discussions. This turned out to be an excellent solution because some answers were really long and complicated.

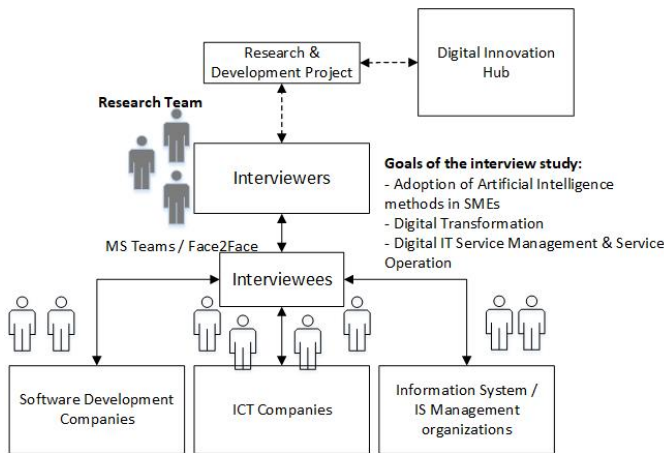


Fig. 1. Context of our interview study

Transcript files were stored as digital files in the project’s digital, cloud-based work environment (internal Teams environment) and shared among the research project team. Each interview transcript was numbered and named according to predefined naming conventions: ordernumber, name of the study, status of transcript: rawdata/validated. Transcript files were sent to interviewees for short validation and interviewees were offered an opportunity to remove or change their answers.

III. FINDINGS OF THE INTERVIEW: AI AND DIGITAL LITERACY

Figure 1 shows the context of our interview study. This paper shows preliminary findings from first eight interviews and from preselected four interview questions that formed our research questions.

Transcripts were coded according to a thematic content analysis technique (a category class was allocated to each answer). During the first round, we did not pay a lot of attention to duplicate categories.

A. How evolvement of AI & digital literacy skills is supported by software development/ICT organizations’ managers and employees?

The first topic that we focused in exploring digital literacy was how managers of software and technology firms had supported the development of AI skills and competences. We observed that one answer from an interviewee may result in several category classes.

- “By innovating new services that utilize AI and identifying demand and customer need for AI solutions. Additionally, we have recruited AI specialist to our company.”**Class:** Recruitment of AI specialists, Identify customer’s AI needs, Service innovation
- “I have not participated myself in AI training events. However, I support aims to do work tasks smarter. I participate in introduction of AI in those parts that are understandable for me. I act more like a coach / inspirator in AI matters.”**Class:** Support for smarter work, Coaching

- “I have not been able to support and have not had an opportunity to participate in AI development”**Class:** No support
- “I participated in Elements of AI course and studied AI topics myself. I have also explored AI-powered apps that support our business such as Trello Butler. We have saved quite a lot of efforts with that app (avoided around 6000 UI clicks).”**Class:** Personal AI learning, Exploring AI features
- “I have a ’bad’ habit to link all interesting articles and videos to our team’s Slack. Thus, information sharing is one way to support. By sharing links and webinar invitations and encourage colleagues to participate in these events.”**Class:** Sharing AI-related information
- “I have not supported because AI has not been in our core focus yet. However, if we start purchasing a new application, we need to observe and think whether there are some AI features available (cherries on the cake) and whether it is possible to include those features to that application.”**Class:** Exploring AI features
- “We have organized general information sessions to our personnel and encouraged our staff to make their work more visible and we have also rewarded employees based on it. Developing AI competences is among employees’ personal goals.”**Class:** Organizing AI information sessions to staff, Rewarding staff on AI work, Linking AI to employee’s personal work goals.
- “Not at all yet”**Class:** No support

B. How AI and related technologies are used in software development/ICT organizations?

The second research question focused on identifying AI technologies and targets for AI usage in software development and ICT organizations.

- Machine vision and machine learning as well as Natural Language Processing in our products and services. For example, in care facilities one can listen operational instructions. **Class:** NLP, Machine vision, Machine learning)
- We use data lakes, Azure cloud technologies and maintain user information concerning Office 365 services. I do not know about usage of AI technologies. **Class:** Azure cloud, data lake, O365
- Azure for managing user right information, AWS cloud in server management, we also store information to Dropbox cloud storage, Google Ads for promoting our products and services. **Class:** Azure cloud, AWS cloud, Dropbox, Google Ads
- We have AWS virtual servers, cloud based file management and a web-based support system (a contact form for ordering new items). Some applications we use have AI features. **Class:** AI-powered apps, AWS cloud, cloud file storage
- Facebook and Google ads. We obtain services that utilize these two. Storing information and centralizing

it. We have a chatbot introduction project running.
Class: Facebook, Google Ads.

- We have a commercial chatbot service, we use Requeste system for managing support tickets and Azure cloud. **Class:** Commercial chatbot, Requeste support ticket system, Azure cloud.
- We do not use Machine Vision in our own work but for customers we do. We use Machine learning and neural networks a lot. We use cloud services almost for everything. Azure, AWS, Google.. We have a service portal that we have built on ServiceNow. **Class:** Azure cloud, AWS cloud, Google cloud, Machine vision, Machine learning, Service portal
- We have NLP/NLU (an AI-based bot), we use Azure and AWS and self service portal. **Class:** Azure cloud, AWS cloud, NLP, NLU, AI bot, Service portal

C. Impacts of AI to daily business operations?

Concerning the third research question, we captured what types of impact AI may have to software development organizations' and ICT organizations' daily business operations. Interviewees were guided to identify impacts to predefined business processes: Customer service, sales and marketing, financial management, human resources management, logistics, IT and free choice. Additionally they were asked to describe rationale for their choices.

- "In application development, we utilize various AI algorithms and we develop AI solutions to our customers. Regarding sales and marketing, we could use more analytics for marketing purposes, for example, with Facebook's own AI one can target marketing campaigns."
- "In customer service, AI helps in routing tickets automatically over the first support level or with small amendments. In financial management AI helps in processing purchase invoices or routing them to a correct person. In inventory management, AI may trigger alerts automatically when thresholds for inventory saldos are exceeded. AI shall save time in those areas where it is possible to utilize it. "
- "Customer service: when customers send requests, automation can process them smoother and we can reduce / avoid paper notes. AI also helps in monitoring sales and marketing by automating the monitoring. AI can be used to monitor servers if there are a lot of customers using systems (loads can be seen beforehand) "
- "Through AI, one does not need to wait for customer service and level of automation can be increased. AI may also result in personalized service and customer service staff can focus on delighting customers in interactive situations. Self service portals enable employees and customers to do things by themselves. For IT organizations, AI can help improving information security and preparing for Denial of Service attacks. AI can detect potential attacks and route the traffic

elsewhere because there is some simple artificial intelligence in routers. "

- "Especially sales and marketing. It is a big challenge for us to analyze the data. I see already now that many organizations develop their own services on the top of Google and these services help them to identify correlations in data."
- "Customer service: for us customer service is the biggest part of our business. Thus, everything that makes it more effective shall improve our business most. It can bring automated recording of cases and workflow automations. These issues free more work time and improve the data validity. From the perspective of financial management, the whole invoicing could be automated and checked that accounts and reference numbers are correct. "
- "Employee satisfaction has increased, customer service process is faster, throughput times are better, AI has had comprehensive effects to customer satisfaction, automation works more effectively and with less errors than a human."
- "We launch increasingly more chatbots in customer service and logistics and inventory management utilizes AI. "

D. How AI is linked to software development/ICT organizations' productivity?

The final research question addressed the linkage between artificial intelligence and the organizational productivity in the interviewee's organization. The original questions in the question form addressed also links between AI and wellbeing at work, however, these answers were excluded from this paper due to space limitations:

- "Concerning productivity, we produce AI services but we do not exploit AI ourselves."
- "Related to financial management AI decreases workload in invoicing. If we can introduce better solutions, we can reduce management's workload."**Class:** Decreased workload
- "Yes of course there is a link if we can get things that makes work faster and actually helps when we do not do unnecessary manual work. AI has to be brought into right targets. We welcome AI. Sure, there are things in various domains where AI can help."**Class:** Eliminates manual work, makes work faster
- "Manual work is not among the most motivating work. Through automation, we have more time for creative work. In our company, automation removes clicks in the UI. Less clicks and more time for drinking coffee."**Class:** Eliminates manual work, more time for creative work
- "There is direct connection if you look at marketing. We have so much data. If we had to perform these tasks ourselves and with our own brains, it would be impossible. Now, when we can rely on AI provided

by existing platforms, it is a big plus.”**Class:** Helps in processing large amounts of data

- “It is very close to all processes where we can use automation and machine learning. These can be utilized for example automated ticketing. It would enable people focusing on more demanding problems or communicating with people. When the basic reporting is ok, we can start creating prediction models of our customers and own finance.”**Class:** Automated ticketing, enables focusing on demanding work, creates basis for predictions
- “To a significant extent, AI results in productivity and it should be introduced more and more. It makes work faster and predictive and correlates with profitability and productivity.”**Class:** Makes work faster, affects profitability
- “There is a positive connection. There are processes in the background and we aim at improving them continuously in order to make our operations smoother and more effective.”**Class:** Smoother and effective operations

IV. ANALYSIS

The data analysis was performed by using thematic content analysis technique for the interview data. The goal of the analysis was to categorize interview data to classes and identify frequently used classes. Regarding the first research question, we identified the following categories on management commitment to support the organization’s AI skills:

- Recruitment of AI specialists,
- Service innovation
- Identify customer’s AI needs
- Support for smarter work
- Coaching/inspiring
- Personal AI learning,
- Exploring AI features in products
- Sharing AI-related information
- Organizing AI information sessions to staff
- Rewarding staff on AI work
- Linking AI to employee’s personal work goals
- No support

According to our observations, only one of the interviewed organizations demonstrated clear management commitment for supporting AI. In that company, they had increased AI awareness within the organization, introduced rewarding mechanisms for staff and also taken care that AI was visible in employees’ personal development path. However, other activities we identified support well the management’s work on getting people focused on AI. While used together these activities (classes) provide management a very good start for AI roadmap.

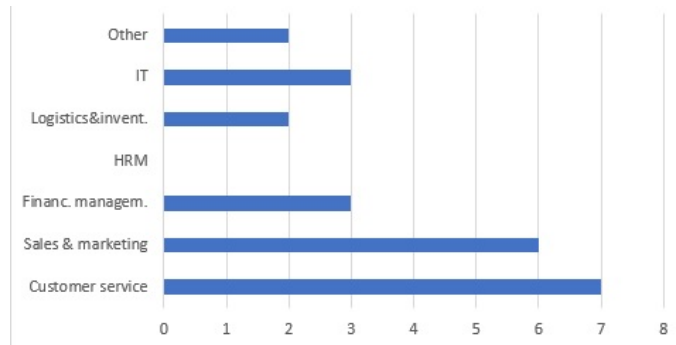


Fig. 2. Impact of AI on organizations’ business processes

Related to the second research question, identified classes revealed the use of common AI types (conversational AI (NLP), machine learning, machine vision) and strong existence of cloud service platforms (Azure, AWS) but also AI-powered services such as Google Ads. Regarding the third research question (impact of AI), we analyzed the answers regarding the frequency of business processes mentioned by interviewees. Figure 2 shows our findings. Each interviewee was asked to select three business processes from the list of predefined processes that he/she thinks AI is going to affect in the near future. Predefined process areas were: customer service, sales and marketing, financial management, human resources management, logistics and inventory management, information technology and other (free selection by the interviewee). According to our interview findings, customer service was most frequently mentioned (7/8 interviewees) process to be affected by AI in the near future.

The thematic content analysis of the answers to the fourth research question resulted in the following category classes.

- Decreased workload
- Eliminates manual work
- Makes work faster
- More time for creative work
- Helps in processing large amounts of data
- Automated ticketing
- Enables focusing on demanding work
- Creates basis for predictions
- Affects profitability
- Smoother and effective operations

Our first observations on these findings was that ‘Makes work faster’ was mentioned several times. The key message in the findings was that AI provides tools for automation and opportunity to eliminate non-valuable, routine and manual, demotivating work tasks while resulting in more time for more meaningful work activities and human to human communications. However, organizations should carefully evaluate where to use artificial intelligence because it does not fit everywhere.

V. CONCLUSION

In this paper, we aimed at answering the research problem: How traditional IT companies are approaching AI and advanced digital technologies? We used an interview research method to collect data from Finnish software development and information technology organizations. Our results contribute to the research field of software engineering and service science by providing new knowledge of AI adoption, targets of AI usage and impacts of AI to operational processes.

Concerning the first research question, our thematic content analysis revealed several ways how managers and employees support development of AI skills in their organizations: by personal AI learning, exploring AI features of products they are purchasing, sharing AI-related information (such as web links and AI-related webinar invitations), organizing AI information sessions to staff, rewarding staff members on visible AI work, and linking AI to employee's personal work goals.

Through the second research question, we received information on current AI & digital technologies used by the companies. Cloud technologies were most frequently mentioned technologies, especially Azure. From AI side, both machine learning and NLU/NLP from conversational AI was clearly mentioned in two of the eight interviewees. Some of the companies had ongoing chatbot projects but the interviewees could not provide any details on technologies used in those projects. Furthermore, machine vision was mentioned by two interviewees and one of those stated that they use machine vision in a customer project.

Related to the third research question, our findings showed that customer service is the process area to be most likely affected by AI in the near future followed by sales and marketing. Our study revealed few IT-related AI impacts such as better monitoring of servers and improved information security though better detection of Denial of Service attacks.

Our final research question addressed the relation between AI and productivity. AI provides tools for powerful tools for automation and enables organizations to eliminate non-valuable, routine and manual, demotivating work tasks which at the same time frees more time for more meaningful work activities and communicating with customers and employees.

There are certain limitations related to the interview method that we utilized. First, data were collected from 8 interviewees by using standard interview data collection procedures. Increasing the number of interviewees (especially senior business managers and programmers) could have provided new insights and experiences on applying AI services.

Second, thematic content analysis was used for transcribed data but the analysis and creation of category classes was performed by one person. Inviting more people to assist the data analysis would have very likely result in a richer set of categories. Third, due to space limitations only four questions from the interview questionnaire were selected for this paper. It was very difficult to prioritize content. However, this provides us a fruitful foundation for further research where we can present the rest of the interview results and new emerging categories on AI adoption.

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