5th UUM International Qualitative Research Conference (QRC 2022)
28-30 November 2022, [Online] Webinar

Methods of Applying IR4.0 Technologies in Improving Organizational Structure and Positions: The Case of Malaysian Public Agencies

Syafini Samsudin*[a], Mohd Hizam-Hanafiah[b]
[ab]*Faculty of Economics and Management, Universiti Kebangsaan Malaysia, Bangi, Malaysia*

Abstract

This article explores the methods of applying Fourth Industrial Revolution (IR4.0) technologies in improving the organizational structure and positions of Malaysian public agencies. Socio-technical Systems Theory, Learning Organization Theory, and Theory of Disruption are discussed as a Theoretical Framework of this article. Employing the qualitative methodology of grounded theory, data was collected from public officials through interviews and a focus group discussion. The result shows seven themes emerged in two categories; management and technology. The themes in the management category are top management leadership and strategic organizational planning, while for the technology category, the themes are big data analytics, system integration, cloud computing, the Internet of Things, and 3D printing. Four research propositions have been developed to suggest the relationship between methods of applying IR4.0 technologies and improving organizational structure and positions. The research provides empirical evidence on methods of applying IR4.0 technologies in public agencies, specifically to improve organizational structure and positions.

Keywords: IR4.0, Industry 4.0**,** organizational structure and positions, public agency, Malaysia

1. INTRODUCTION

The Malaysian Government has allocated 36.3 percent of its RM307.5 billion 2021 budget for the emolument of public officials and pensioners (Kementerian Kewangan Malaysia, 2020). The allocation is rising steadily since calculations are based on the overall number of public servants, annual increments, and retirement payments. The government has since controlled the number of public positions to 1.71 million, limiting any creation of new positions except through replacement or redeployment of current staff. The same policy applies to all restructuring proposals of public agencies (Kementerian Kewangan Malaysia, 2021).

However, with the growing number of citizens and the expectation to perform more functions, public agencies are asking for more positions, pushing the government to explore the possibility of using IR4.0 technologies to resolve the issue. Studies have shown that these technologies increase revenue and decrease the need for human workforce (Anshari, 2020; Braccini & Margherita, 2018; Kagermann et al., 2013), and governments worldwide have taken the initiative to integrate IR4.0 technological approaches into their policy planning (Yang & Gu, 2021). The Malaysian Government announced the implementation of the Public Sector Big Data (DRSA) pilot project in 2013 (Hamzah et al., 2020) and three national policies based on the use of IR4.0 technologies, namely the National Digital Economy Blueprint, the National Fourth Industrial Revolution Policy, and the 12th Malaysia Plan (Unit Perancang Ekonomi, 2021). The use of IR4.0 technologies in public service has been emphasized in these policies.

*Corresponding author.
E-mail: syafinisamsudin@gmail.com

Studies discussing the application of IR4.0 technologies in improving organizational structure and positions are plenty, but the focus is limited to the business sector or private entities (Braccini & Margherita, 2018; Cimini et al., 2021; Davutoglu, 2020), leaving a gap in studies for the public sector. Moreover, the objective of business entities and public entities is different since the aim of increasing revenue and eliminating costs may not be applied to public agencies. Gajdzik et al. (2021) emphasize that the use of IR4.0 technologies is uniquely determined by the nature of the industry and the organization itself; therefore, the use of technologies in public agencies depends upon the need of the public sector. Hence, this study focuses on one aspect of the sphere by identifying the methods of applying IR4.0 technologies in the public sector, especially in improving organizational structure and positions. This study will contribute to the literature on IR4.0 and public service, as well as increase the understanding of how the application of IR4.0 improves organizational structure and positions in public agencies, subsequently answering the research question: *what are the methods of applying IR4.0 technologies in improving organizational structure and positions of Malaysian public agencies?*

2. LITERATURE REVIEW

2.1 The Industrial Revolution

The world has seen four industrial revolutions. The First Industrial Revolution started during the mid-18 century in England with the invention of the steam engine, substituting the use of manpower for machines (Pereira & Romero, 2017). The Second Industrial Revolution began almost 100 years later, with the introduction of electricity, thus flourishing mass manufacturing (Jain & Ajmera, 2021). The invention of microchips marked the Third Industrial Revolution at the end of the 20th century, changing technologies from analog to digital, introducing personal computers, the Internet, handphones, robots, and automation (Rymarczyk, 2020). The Fourth Industrial Revolution (IR4.0), also known as Industry 4.0, was introduced in German in 2011 as an initiative by the government to develop the industrial sector. The initiatives became revolutionized, mainly because the technologies blurred the line between the physical, digital, and biological worlds (Poszytek, 2021).

Among the critical characteristics of IR4.0 technologies are digitalization, optimization, human-machine interaction, automatic data exchange, and communication advancement (Roblek et al., 2016). These characters serve as elements for nine pillar technologies of IR4.0: big data analytics, autonomous robots, simulation, system integration, the Internet of Things (IoT), cyber security, cloud computing, additive manufacturing or 3D printing, and augmented reality (Rüßmann et al., 2015; Yang & Gu, 2021). These technologies developed into other technologies with numerous applications, such as artificial intelligence (AI), autonomous car, and blockchain (Rymarczyk et al., 2019).

Parallel to the effect of other industrial revolutions, IR4.0 transformed the way jobs are done, bringing changes in job design, job environment, and job structure (Herrero et al., 2020; Kagermann et al., 2013). Its technologies are disruptive because they change all production aspects, from product design to marketing to after-sales services (Miśkiewicz & Wolniak, 2020). Such changes divide the work structure into two continuums, one of the high-skill workers in an organic structure and another of low-skill workers with high possibility of being replaced by machines (Wilkesmann & Wilkesmann, 2018), as well as possibly changing the structure of an organization (Davutoglu, 2020).

2.2 Methods of applying IR4.0 technologies

The discussion on methods of applying IR4.0 in organizations mainly falls into two categories; management and technology. Regarding management, the literature is divided between the role of government and the role of the organization. The government is expected to develop and implement public policies to assist businesses in adapting to the technologies (Erro-Garcés & Aranaz-Núñez, 2020; Krishnan et al., 2021; Reis et al., 2021), provide advanced IT infrastructure and reliable digital network at a competitive price (Jain & Ajmera, 2021), and aggressively prepare for the coming of IR4.0 especially in developing countries (Erasmus, 2021). While for the organization, an organization must have strategies or roadmaps to adopt IR4.0 technologies (Erboz, 2020; Nagy et al., 2022; Shinkevich et al., 2021), recognize top management as the primary enabler of IR4.0 implementation (Krishnan et al., 2021), sufficient financial support from the management, continuous training and reskilling in operating as well as maintaining the technologies (Jain & Ajmera, 2021), improve its technological readiness (Hizam-Hanafiah et al., 2020), practice organizational learning (Belinski et al., 2020), and engage in collaborative employment relation with the union (Rutherford & Frangi, 2020).

The technology category refers to the use of IR4.0 technologies in industries such as advanced robots being operated to perform repetitive tasks, cloud computing maintaining and monitoring operations remotely, additive

manufacturing producing 3D printing of high-demand products and critical parts, augmented reality provides an almost real-life working environment, horizontal and vertical integrations using AI are utilized to disseminate knowledge to employees, IoT is merged with drones for surveillance activities, and big data analytics is generating real-time forecasts (Lepore et al., 2021). In addition to that, advancement in cyber-physical devices is making autonomous vehicles possible, nanomaterials are producing products of lightweight in the automotive industry, construction industry, health industry, and environmental protection, blockchain is developed for secured online transactions, and digital twin is creating digital simulation model (Rymarczyk, 2020). To apply IR4.0 technologies, companies start with automation before selecting only the most relevant technologies, and not utilizing all the technologies at once (Szabo et al., 2020).

2.3 Organization and the role of human resource practitioners

An organization is formed to execute a function or achieve a goal, and the structure is designed to ensure that the objective is attainable. Mintzberg (1979) proposes the Five Organizational Structure Model of organization, based on five main components: the Operating Core, Middle Line, Strategic Apex, Support Staff, and Technostructure. From the components, five structures of organizations are developed: simple structure, machine bureaucracy, professional bureaucracy, divisionalized form, and adhocracy, with each structure being dominant in one component depending on the nature of business, the time, and the environment (Lunenburg, 2012).

In describing the organizational design, Galbraith (2002) suggests the Star Model with five dependable dimensions: strategy, people, structure, reward, and process, with strategy taking the lead by determining the direction of an organization. Explaining organizational structure and positions, Cimini et al. (2021) refer to Galbraith's structure as having two primary constructs: number of hierarchy (Pugh et al., 1968) and span of control (Ouchi & Dowling, 1974), while process refers to the design of positions within an organization and relates to the roles of individual position. Changes in structure and positions in an organization are influenced by external factors such as globalization, technology, customer, and competition, as well as internal factors such as development strategy, type of activity, inefficient structure, and qualifications of its members (Kalowski, 2015).

Organizing structural changes, redesigning job descriptions, reviewing individual roles, and determining the number of positions needed are the responsibilities of human resource practitioners, especially during IR4.0 because of the socio-technical elements associated with adopting new technologies (Sony & Naik, 2019). Human resources practitioners must strategize executing change management (Lord, 2020) due to the possibility of reducing the current workforce (Ziaei Nafchi & Mohelská, 2021). Other than providing reskilling training (Kiss & Muha, 2018), human resource practitioners must be able to think strategically and act as change agents (Dhanpat et al., 2020; Poba-Nzaou et al., 2020; Yusuf et al., 2017) to keep their relevancy in the structure since routine HR tasks can easily be automated using IR4.0 technologies (Drljača et al., 2020).

In Malaysian public services, the task of evaluating organizational change in structure and positions lies on a central agency at the federal level, whose functions include developing human resources policies for public agencies. Although human resource practitioners are empowered to manage within their respective agencies and have the freedom to plan for their structure and positions, the implementation is subject to approval from the federal level as a result of financial implications sustained by the government on the process (Bahagian Pembangunan Organisasi, 2020).

2.4 Theories on IR4.0, organizational structure and positions

Three theories serve as a framework for this study. The first is Socio-technical Systems Theory (STS), which suggests that an organization is a combination of social and technical parts and is open to its environment (Trist et al., 1993). The social element of people and their relationships, and technical elements such as digital applications, equipment, and processes, must work together to achieve the objective (Appelbaum, 1997). An enlarged perspective on STS and Industry 4.0 by Cimini et al. (2021) suggest that a lean organizational structure supports the effective adoption of Industry 4.0 technologies, and technologies should not guide the restructuring of the organization but rather leverage them to make the organization capable of adapting to the new process by giving ample training. This study relates to the theory by identifying socio-technical elements in public agencies and how these elements determine organizational structure and positions.

Learning Organization Theory proposes that to be competitive and achieve their goals in changing environments, organizations must learn to change by making conscious choices in response to the environment (Senge, 1996). Learning organization has five disciplines: system thinking, personal mastery, mental models, shared vision, and team learning, which are necessary if the organizations are to learn (Fillion et al., 2014). Members of learning

organizations continuously challenge themselves to be more innovative and adaptive to the changing environments, thus moving away from simple employee training into organizational problem-solving (Dawoood et al., 2015). Since IR4.0 technologies are new and keep developing, this theory relates to organizations' need for continuous learning and constant reskilling to survive (Belinski et al., 2020; Piątkowski, 2020) and ultimately affects the organizational structure by altering work process and job design.

Another theory that relates to this study is the Theory of Disruption, which states that technological advancement is causing disruptive changes in the world (Christensen & Raynor, 2003). IR4.0 technologies are indeed disruptive technologies, it changes almost everything related to the way businesses are done (Herrero et al., 2020; Kagermann et al., 2013; Miśkiewicz & Wolniak, 2020), and it keeps on growing and creating more disruption to older technologies (Yang & Gu, 2021). Since the study is about IR4.0 technologies and disruption impact on organizational structure and positions, the Theory of Disruption is suitable for explaining the relationship.

3. METHODOLOGY

The study was exploratory and conducted using a qualitative approach. It aimed to identify the methods of applying IR4.0 technologies in improving organizational structure and positions in Malaysian public agencies. Given the lack of studies in the public sector addressing the issue of organizational structure and positions during the IR4.0 era, this study adopted the grounded theory research design by Glasser and Strauss (1967) and an inductive approach using Constructivist Grounded Theory (Charmaz, 2006). Data was collected through semi-structured interviews and a focus group discussion. A combination of convenience, purposive, and theoretical sampling strategies was employed to ensure that all informants could contribute considerably to the study (Bryman, 2008; Miller & Salkind, 2002). Convenience sampling was employed during pilot interviews because the informants were easy to access, available, and willing to participate. In selecting informants after the pilot interviews, purposive sampling was applied to identify information-rich or experienced informants based on the following criteria: (1) officers in Federal Ministry/Department, State Government, Local Government, or statutory body under government's control; (2) middle to top-level managers, of Grade 48 to Grade JUSA C (top position of the public sector); (3) occupying management positions or human resource or organizational development; (4) having at least two years of experience in organizational development. As for theoretical sampling, the technique was utilized during the selection of informants for focus group discussion by limiting the informants to Federal Ministry/Department responsible for policy formulation.

In the beginning, two sessions of in-depth pilot interviews were conducted, and the questions were revised based on those interviews. The final interview guide has eight semi-structured questions, including introductory questions. A formal request was sent via email to 23 heads of agencies, but only 22 agreed to participate, with one agency refusing due to managerial issues. Within four months, 11 sessions of semi-structured interviews were conducted with 16 participants, and a focus group discussion of 10 informants was organized. The profile of informants is shown in Table 1. Of all the interview sessions, eight sessions were conducted face-to-face, while three interviews were conducted online. Face-to-face interviews were held in informants' offices all around Malaysia. The interviews ranged from fifty minutes to one hour and twenty minutes, and all 16 informants agreed to an audio recording. Meanwhile, a focus group discussion was organized at a later stage of data collection, focusing on informants located around Putrajaya (federal government administrative centre) and Kuala Lumpur (capital of Malaysia), as well as a triangulation method to increase the validity of the data. The discussion took three hours, and all informants agreed that the session was video recorded. All questions during interviews and focus group discussion were asked in an open-ended manner and emailed in advance, and the questions were the same for all informants. The recordings were transcribed verbatim into text for data analysis and coded using Strauss and Corbin's (1998) open, axis, and selective coding. ***Atlas.ti*** software was utilized to help manages the data and ensure all relevant data were coded. Data saturation was reached during the interviews when no new code emerged (Glasser & Strauss, 1967) and confirmed during focus group discussion.

Table 1. Profile of informants (n = 26)

No.	Code	Job Function	Grade	Type of Agency	Sector of Agency
1	B1	HR	48	Statutory Body	Economy
2	B2	OD	52	Statutory Body	Agriculture
3	B3	Management	48	Statutory Body	Development Authority
4	B4	Management	54	Statutory Body	Education
5	B5	HR	JUSA C	Statutory Body	Education
6	B6	HR	52	Statutory Body	Education
7	P1	Management	52	Local Government	City Council
8	P2	Management	54	Local Government	City Council
9	P3	Management	48	Local Government	City Council

10	N1	HR	54	State Government	Administration
11	N2	OD	52	State Government	Administration
12	N3	HR	54	State Government	Administration
13	N4	OD	52	State Government	Administration
14	N5	OD	48	State Government	Administration
15	N6	HR	54	State Government	Administration
16	K1	OD	52	Federal Ministry	Infrastructure
17	K2	OD	54	Federal Ministry	Education
18	K3	HR	54	Federal Ministry	Economy
19	K4	OD	52	Federal Ministry	Security
20	K5	OD	52	Federal Ministry	Health
21	K6	OD	52	Federal Ministry	Security
22	K7	OD	52	Federal Ministry	Security
23	J1	HR	54	Federal Department	Infrastructure
24	J2	HR	48	Federal Department	Infrastructure
25	J3	OD	48	Federal Department	Security
26	J4	HR	48	Federal Department	Administration

Note: HR, human resource; OD, organizational development.

4. RESULTS AND DISCUSSION

The use of STS Theory, Learning Organization Theory, and Theory of Disruption as guidance in understanding the relationship between humans, organizations, and technologies, assisted in keeping the focus when encountering rich sources of data from the interviews. Since discussions on IR4.0 and organizational development are plenty but the subject of public agencies is new, the use of these theories as a theoretical framework greatly supports the initial stage of data analysis.

Based on data analysis, seven themes emerged which can be categorized into management and technology. For the management category, the themes are top management leadership and strategic organizational planning. As for the technology category, the five themes that emerged are big data analytics, system integration, cloud computing, the IoT, and 3D printing. These themes are developed into four research propositions.

4.1 Management category

In the Malaysian public sector, each agency is headed by a Head of Agency, who is responsible for every single aspect of the organization. The head assumes managerial function, usually referred to as the top management, and is structurally assisted by at least two deputies; one oversees the organization's core function, and the other manages the support services assisting the core functions.

4.1.1 Top management leadership

This study finds that top management leadership is the most critical managerial method in applying IR4.0 technologies to improve organizational structure and positions, in line with Herrero et al. (2020) and Krishnan et al. (2021). Without top management leadership, consent, or commitment, the technologies can neither be applied nor impact structure or positions.

> *"For me, the most important is a blessing from top management, because when he inspires, and tells us that is the way he wants things done, he will make sure the whole agency moves towards that"* (Informant K1).

It is safe to assert that the ability to foresee, conceptualize and commit to new technologies lies only in leaders with future-looking characteristics. These leaders can see the future beyond the limit of time and know exactly what strategies to use to create that future. The leaders start by clarifying the organization's direction and be firm in ensuring the subordinates work towards the direction.

> *"For me, the first thing is a direction. Based on the direction, we will review our work processes to make sure the processes support the direction, from that, we will know what (positions) we need, and how many (number of positions)"* (Informant B2).

> *"In allocating positions, the top management must be firm, we have to convince them that IR4.0 technologies have taken over the human jobs"* (Informant B5).

In addition to providing direction, top management must realize that technologies need investment, and rational budget decisions must be made. Since change takes time, top management must maintain working towards the direction.

4.1.2 Strategic Organizational Planning

The study shows that strategic organizational planning is one of the managerial methods of applying IR 4.0 technologies to improve organizational structure and positions. The strategy must come first, especially in the constantly changing environment of IR4.0 (Nagy et al., 2022).

> *"... we must have strategic planning, ranging from five to ten years. Only then will we be able to plan for human resources management. The plan must cover many years, to be able to see which positions are to freeze, and which are to trade off; these must be included in the strategic plan. That is why a strategic plan is very important, from the plan, we will know what technology to use, and how it affects the positions*" (Informant N4).

> *"We have White Paper on the ministry's policy, in which we have outlined all the strategic plan, ministry's plan as well as all other agencies under this ministry. And the plan is in line with current needs because, in IR4.0, the most important domain is cyber security, so the ministry is focusing on the development in that domain"* (Informant K6).

Organizational planning in government agencies is usually documented in strategic planning, covering a duration of three to five years. In ensuring that the use of IR4.0 technologies is translated into a workable plan, agencies must develop a strategic organizational plan that specifies the need and methods to use technologies. Since the preference for technology is determined by the nature of service in a particular agency, this plan will identify which kind of technologies to use and for what purpose,

4.2 Technology category

As the nature of business is different between the public and private sector, along with the fact that the application of IR4.0 technologies are exclusively determined by the organization itself and might not be the same for other organizations (Gajdzik et al., 2021), this study finds that public agencies are not applying all technologies, and the application is different based on the function of agencies.

4.2.1 Big data analytics

In line with government initiatives for national-level big data analytics (Hamzah et al., 2020), this study finds many instances of using big data analytics in public agencies. Using big data analytics, usually combined with the IoT and AI, improves organizational structure and positions.

> *"One of the data analytics we made is for staff movement – we can see the grade, the age, the duration of service, to the extent that we can analyze by specific position, which PTJ (office) and so on, so with data analytic, we can plan the actual need because we have to maintain an acceptable ratio of lecturers and students"* (Informant B5).

Data analytics can predict future scenarios so that HR managers can strategically plan the need for new positions. It affects intake, for example by ensuring that intake is made only when necessary, preventing unnecessary intake such as for facilities under construction. Data analytics also improves organizational structure and positions by replacing routine work predominantly executed by humans, as well as in complex routines with exact precision.

> *"Before this, in open-up surgery, we need five specialists, but with this AI technology, only two people are needed. Then we can determine that technologies minimize the need for positions (in the agency), minimizing the overall medical impact or implication. Only a minimum number of positions is needed to handle the whole thing"* (Informant K5).

The use of AI had significantly reduced the need for traditional human positions since technology can replace humans. Thus, a lesser number of positions are needed to execute more and more functions, improving the organizational structure.

4.2.2 System integration

Judging from the size of public agencies and the rate of digitalization initiatives, the study finds that public agencies require system integration. Applications are built internally, serving purposes and solving managerial problems, but connecting all the applications is a real challenge since the applications are not integrated and function independently.

> *"We need system integration. In this agency, we have a lot of systems, but the systems are not integrated. If we can have an integrated system, I believe there are areas where we don't need many positions"* (Informant B3).

> *"If we have a well-integrated system, we can share the data, and all departments can use the data without the need to ask the data from the customer anymore, so if an application is filed, we only ask for data, not inside our integrated system"* (Informant B1).

The ability to integrate between systems promotes data sharing between government agencies, impacting the current work process. It boosts shorter processes, preventing overlapping procedures in data sharing, and eventually resulting in a lesser number of positions needed in executing a task in multiple agencies.

4.2.3 Cloud computing

This study shows that cloud computing can solve critical managerial issues of public agencies such as lack of positions, inefficient work processes, need for huge record storage, more extensive working areas, and time wasted.

> *"In data storage, cloud computing uses servers, so the officers in charge of maintaining records can be limited. Now we have two positions in charge of records, before this, we needed five positions"* (Informant B2).

> *"We need cloud computing for data storage because we need to review the data when an agency is applying for restructuring. If we are using a manual system, it will take a lot of time to search for a physical file, if everything is in one system, one place, we can access the system to check, update and save"* (Informant N3).

With cloud computing, the average time in managing government records becomes much shorter, retrieving time becomes faster, and storing old records becomes easier. It greatly lessens the need for positions in charge of record keeping process. In addition to that, cloud computing ensures a faster way of learning institutional memory by new officers. There will be a lesser need for face-to-face job training by senior members of organizations. In maximizing the benefits of cloud computing, the Malaysian Government has its cloud computing service known as *MyGovCloud@PDSA,* an initiative to execute the MyDigital policies (Unit Perancang Ekonomi, 2021).

4.2.4 The internet of things

There are a lot of benefits in applying the IoT in public agencies. Technology is changing the work process in multiple sectors such as agriculture, enforcement, and security. The work process will ultimately change the organizational structure and the need for positions.

> *"In agriculture, the IoT affects the way process is done, for example, before this, officers needed to collect the data from samples and bring them to the lab for testing, but now, they just insert a tool, and the tool will display all information needed in no time. So, we don't need many positions, the IoT has been able to simplify the way jobs are done, minimize the hassle, and helps in controlling the number of positions needed in our organization"* (Informant N3).

> *"We use the IoT to monitor, we have started using drones to monitor industrial areas, to identify pollution spots, factories releasing harmful smoke – we monitor the water, the air, including seas and rivers, we get the data automatically, so if there is an anomaly, the system triggers the control room, and we can despatch our officers immediately"* (Informant P2).

The use of IoT had reduce lengthy working processes, resulting in a lesser need for positions but at the same time extending the ability of a position to execute more functions. IoT can be applied by wide sectors in government

such as agriculture, enforcement, border security, and weather prediction, thus having the potential of reducing more number of positions needed in exercising specific functions, thus impacting the organizational structure.

4.2.5 3D printing

3D printing is new to public agencies, and this study finds the application of this technology only in the health sector. Still, the impact is significant to the extent that it changes the structure of dentistry and eliminates one particular service. The eliminated positions are then converted to positions essential to the agency.

> *"Nowadays, we don't need dental therapists anymore, we used to have this position in the dental clinic, making dentures, from last year onwards, we don't have this position anymore, we are slowly phasing out because we are now investing in the 3D printer"* (Informant K5).

The study shows that the nature of services offered by government agencies which are mostly related to services with human interaction rather than the production of a physical product, is the factor why government agencies are more relaxed in accepting 3D printing. Still, it offers a huge possibility of impacting the need for positions and improving the organizational structure.

5. CONCLUSION

The finding shows that the methods of applying IR4.0 technologies in public agencies are similar to those in private entities (Krishnan et al., 2021; Nagy et al., 2022) in terms of managerial aspects, but differ in terms of technological aspects, but both aspects are influencing organizational structures and positions.

The first theme from the data is the managerial aspect of top management leadership and strategic organizational planning. It shows that the methods of applying IR4.0 technologies in public agencies depend on the managerial aspect first because this is where the funding to acquire the technologies come from. Top management must know the technologies' potential, decide on the need, and plan for their use. Furthermore, the blind adoption of technologies is not recommended (Szabo et al., 2020). Studies must be carried out in a particular field to identify what technologies fit the organization best, and the adaptation process must be planned carefully to ensure the full benefits of the technologies. Therefore, the research propositions of this study are:

RP1: *Top management leadership has a direct positive relationship to the methods of applying IR4.0 technologies in improving organizational structure and positions of public agencies.*

RP2: *Strategic organizational planning has a direct positive relationship to the methods of applying IR4.0 technologies in improving organizational structure and positions of public agencies.*

Regarding technologies suitable for an agency, the finding shows that since public agencies cover vast services, there is so much potential that IR4.0 technologies can improve the organizational structure and optimize the overall number of positions. But still, given the enormous coverage of public services, the reduced number can be channeled to services that need human interaction, because public services are not similar to production lines in factories. For this reason, the authors proposed the following research proposition:

RP3: *The higher the use of IR4.0 technologies in public agencies, the higher the possibility of improving organizational structure and positions.*

RP4: *The higher the use of IR4.0 technologies, the higher the possibility of optimizing public agencies' overall structure and positions.*

This study contributes to STS by highlighting the importance of social aspects of public agencies, without which technology will be irrelevant. Social elements in this study are not just the people and their relationships within the organization, but more importantly the leadership aspect of the management who is accountable for preparing strategic planning. As for Learning Organization Theory, this study suggests that management aspects of a visionary leader and strategic planning are added as characteristics of a learning organization because these characteristics will ensure that the organization keeps on learning despite changes in people. This study also strengthens the idea of Disruption Theory by showing that technological advancement is much more disruptive in public services because the coverage of impact encompasses the whole nation.

As for the implication to the government, this study shows that the most crucial aspect is not surviving the IR4.0, but living the era, and strategically planning for the unknown future using technologies. For that reason, the selection of heads of public agencies must be made among future-looking candidates who are willing to adopt and adapt technologies at better speed and take advantage of IR4.0 technologies. These future-looking leaders will strategically design organizational structure and positions based on utilizing advanced technologies, resulting in leaner structure and optimizing positions. The impact will ripple by enabling public agencies to perform more functions with less workforce, and at the same time optimizing the allocated budget for the emolument of public officials, thus increasing the return on investment. This study also indicates that the current restructuring and positions management policy is sufficient in controlling the number of public officials, provided that the technologies are utilized. In terms of methodological impact, this study provides prepositions to be tested in future studies because the methods of applying advanced technologies had been set forth for public agencies. These prepositions suggest certain traits of managerial aspects and a particular pattern of technologies suitable for public agencies.

While for the limitation, the study cannot be generalized to other countries since the study aims to explore a specific issue. Another limitation is that although the study has informants from all levels of public agencies, those informants do not extensively represent all public sector areas, causing some areas not to be represented. Therefore, future studies should focus on other areas of public agencies.

ACKNOWLEDGMENT

We would like to thank the Public Service Department of Malaysia for funding this study, the National University of Malaysia for providing critical assistance in managing the research, all heads of the department whose consent is vital for the success of this study, and all informants whose willingness to share their views are crucial in understanding and improving the public service in the era of IR4.0.

REFERENCES

Anshari, M. (2020). Workforce mapping of Fourth Industrial Revolution: optimization to identity. *Journal of Physics: Conference Series*, *1477*(7), 072023.

Appelbaum, S. H. (1997). Socio-technical systems theory: an intervention strategy for organizational development. *Management Decision*, *35*(6), 452–463.

Bahagian Pembangunan Organisasi. (2020). *Buku panduan perakuan perjawatan tahun 2020*. Putrajaya, Malaysia: Author.

Belinski, R., Peixe, A. M. M., Frederico, G. F., & Garza-Reyes, J. A. (2020). Organizational learning and Industry 4.0: findings from a systematic literature review and research agenda. *Benchmarking*, *27*(8), 2435–2457.

Braccini, A., & Margherita, E. (2018). Exploring organizational sustainability of Industry 4.0 under the triple bottom line: the case of a manufacturing company. *Sustainability*, *11*(1), 36.

Bryman, A. (2008). *Social research methods* (3rd ed.). Oxford: Oxford University Press.

Charmaz, K. (2006). *Constructing grounded theory. A practical guide through qualitative analysis*. London: Sage Publications Ltd.

Christensen, C. M., & Raynor, M. E. (2003). *The innovator's solution: creating and sustaining successful growth*. Boston: Harvard Business School Press.

Cimini, C., Boffelli, A., Lagorio, A., Kalchschmidt, M., & Pinto, R. (2021). How do industry 4.0 technologies influence organisational change? An empirical analysis of Italian SMEs. *Journal of Manufacturing Technology Management*, *32*(3), 695–721.

Davutoglu, N. A. (2020). The restructuring of the administrational-organisational approaches of businesses in the process of Industry 4.0. *Journal of Life Economics*, *7*(4), 361–372.

Dawoood, S., Mammona, Fahmeeda, & Ahmed, A. (2015). Learning organization-conceptual and theoretical overview. *International Journal of Humanities Social Sciences and Education*, *2*(4), 93–98.

Dhanpat, N., Buthelezi, Z. P., Joe, M. R., Maphela, T. V., & Shongwe, N. (2020). Industry 4.0: The role of human resource professionals. *SA Journal of Human Resource Management*, *18*, 10.

Drljača, M., Štimac, I., Bračić, M., & Petar, S. (2020). The role and influence of Industry 4.0. in airport operations in the context of Covid-19. *Sustainability*, *12*(24), 10614.

Erasmus, M. N. (2021). Public administration in the Fourth Industrial Revolution: implications for the practice. *Gender & Behaviour*, *19*(June), 6.

Erboz, G. (2020). A qualitative study on industry 4.0 competitiveness in Turkey using Porter diamond model. *Journal of Industrial Engineering and Management*, *13*(2), 266.

Erro-Garcés, A., & Aranaz-Núñez, I. (2020). Catching the wave: Industry 4.0 in BRICS. *Journal of Manufacturing Technology Management*, *31*(6), 1169–1184.

Fillion, G., Koffi, V., & Ekionea, J.-P. B. (2014). Peter Senge's learning organization : a critical view and the addition of some new concepts to actualize theory and practice. *Proceedings of the Academy of Information and Management Sciences*, *18*(2), 10–15.

Gajdzik, B., Grabowska, S., & Saniuk, S. (2021). A theoretical framework for Industry 4.0 and its implementation with selected practical schedules. *Energies*, *14*(940), 1–24.

Galbraith, J. R. (2002). Organizing to deliver solutions. *Organizational Dynamics*, *31*(2), 194–207.

Glasser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: strategies for qualitative research*. Chicago: Aldine Publishing Company.

Hamzah, M. A., Mat Yatin, S. F., Yusof, M., Rashid, T. S. L. T. Z., Shuhaimi, H., Suleiman, A. B., Mansor, A. N., & Taib, K. M. (2020). Big data implementation in Malaysian public sector: a review. *International Journal of Academic Research in Business and Social Sciences*, *10*(11), 1461–1474.

Herrero, P., Armellini, F., & Solar-Pelletier, L. (2020). Change management in the context of the 4th Industrial Revolution: exploratory research using qualitative methods. *Journal of Modern Project Management*, *7*(4), 154–175.

Hizam-Hanafiah, M., Soomro, M. A., & Abdullah, N. L. (2020). Industry 4.0 readiness models: a systematic literature review of model dimensions. *Information*, *11*(7), 364.

Jain, V., & Ajmera, P. (2021). Modelling the enablers of Industry 4.0 in the Indian manufacturing industry. *International Journal of Productivity and Performance Management*, *70*(6), 1233–1262.

Kagermann, H., Wahlster, W., Helbig, J., Hellinger, A., Stumpf, M. A. V., Treugut, L., Blasco, J., Galloway, H., & Findeklee, U. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0 : securing the future of German manufacturing industry* (Issue April). Frankfurt: National Academy of Science and Engineering.

Kalowski, A. (2015). Structure Determining Factors of Business Organization. *International Journal of Innovation, Management and Technology*, *6*(3), 206–212.

Kementerian Kewangan Malaysia. (2020). *Anggaran Perbelanjaan Persekutuan 2021*. Retrieved from http://belanjawan2021.treasury.gov.my/index.php/ms/ap-2021

Kementerian Kewangan Malaysia. (2021). *PB3.1 garis panduan langkah-langkah mengoptimumkan perbelanjaan kerajaan*. Retrieved from https://1pp.treasury.gov.my/

Kiss, M., & Muha, L. (2018). The cybersecurity capability aspects of smart government and Industry 4.0 programmes. *Interdisciplinary Description of Complex Systems*, *16*(3), 313–319.

Krishnan, S., Gupta, S., Kaliyan, M., Kumar, V., & Garza-Reyes, J. A. (2021). Assessing the key enablers for Industry 4.0 adoption using MICMAC analysis: a case study. *International Journal of Productivity and Performance Management*, *70*(5), 1049–1071.

Lepore, D., Micozzi, A., & Spigarelli, F. (2021). Industry 4.0 accelerating sustainable manufacturing in the Covid-19 era: assessing the readiness and responsiveness of Italian regions. *Sustainability*, *13*(5), 2670.

Lord, P. (2020). Changing world, changing work. *Contemporary Social Science*, *15*(4), 407–415.

Lunenburg, F. C. (2012). Organizational structure: Mintzberg's framework. *International Journal for Scholarly, Academic, Intellectual Diversity*, *14*(1), 1–8.

Miller, D. C., & Salkind, N. J. (2002). *Handbook of research design & social measurement* (6th ed.). Thousand Oaks: Sage Publications Inc.

Mintzberg, H. (1979). *The structuring of organisations*. Englewood Cliffs: Prentice-Hall.

Miśkiewicz, R., & Wolniak, R. (2020). Practical application of the Industry 4.0 concept in a steel company. *Sustainability*, *12*(14), 5776.

Nagy, A. ., Toth, S. ., Bognar, I. ., & David, F. (2022). Industry 4 . 0 Innovation. *International Scientific Journal "Innovations," 10*(1), 3–5.

Ouchi, W. G., & Dowling, J. B. (1974). Defining the span of control. *Administrative Science Quarterly*, *19*(3), 357.

Pereira, A. C., & Romero, F. (2017). A review of the meanings and the implications of the Industry 4.0 concept. *Procedia Manufacturing*, *13*, 1206–1214.

Piątkowski, M. J. (2020). Expectations and challenges in the labour market in the context of Industrial Revolution 4.0. The Agglomeration Method-based analysis for Poland and other EU member states. *Sustainability*, *12*(13), 5437.

Poba-Nzaou, P., Galani, M., & Tchibozo, A. (2020). Transforming human resources management in the age of Industry 4.0: a matter of survival for HR professionals. *Strategic HR Review*, *19*(6), 273–278.

Poszytek, P. (2021). The landscape of scientific discussions on the competencies 4.0 concept in the context of the 4th Industrial Revolution—a bibliometric review. *Sustainability*, *13*(12), 6709.

Pugh, D. ., Hickson, D. ., Hinings, C. R., & Turner, C. (1968). Dimensions of organization structure. *Administrative Science Quarterly*, *13*(1), 65–105.

Reis, J. S. da M., Espuny, M., Nunhes, T. V., Sampaio, N. A. de S., Isaksson, R., de Campos, F. C., & de Oliveira, O. J. (2021). Striding towards sustainability: a framework to overcome challenges and explore opportunities through industry 4.0. *Sustainability (Switzerland)*, *13*(9).

Roblek, V., Meško, M., & Krapež, A. (2016). A complex view of Industry 4.0. *SAGE Open*, *6*(2), 215824401665398.

Rüßmann, M., Lorenz, M., Gerbert, P., Manuela, W., Engel, P., Harnisch, M., & Justus, J. (2015). *Industry 4.0: the future of productivity and growth in ganufacturing Industries*. Retrieved from https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries.

Rutherford, T., & Frangi, L. (2020). Is Industry 4.0 a good fit for high performance work systems? *Industrial Relations*, 751–773.

Rymarczyk, J. (2020). Technologies, opportunities and challenges of the Industrial Revolution 4.0: theoretical considerations. *Entrepreneurial Business and Economics Review*, *8*(1), 185–198.

Senge, P. (1996). Building learning organizations. *IEEE Engineering Management Review*, *24*(1), 96–104.

Shinkevich, A., Barsegyan, N., Petrov, V., & Klimenko, T. (2021). Transformation of the management model of a petrochemical enterprise in the context of industry 4.0 challenges. *E3S Web of Conferences*, *296*, 06008.

Silva, V. L., Kovaleski, J. L., & Pagani, R. N. (2019). Technology transfer and human capital in the Industrial 4.0 scenario: a theoretical study. *Future Studies Research Journal: Trends and Strategies*, *11*(1), 102–122.

Sony, M., & Naik, S. S. (2019). Ten lessons for managers while implementing Industry 4.0. *IEEE Engineering Management Review*, *47*(2), 45–52.

Strauss, A. L., & Corbin, J. . (1998). *Basics of qualitative research: techniques and procedures for developing Grounded Theory* (2nd ed.). London : Sage Publications Inc.

Szabo, R. Z., Herceg, I. V., Hanák, R., Hortovanyi, L., Romanová, A., Mocan, M., & Djuričin, D. (2020). Industry 4.0 implementation in B2B companies: cross-country empirical evidence on digital transformation in the CEE region. *Sustainability*, *12*(22), 9538.

Trist, E., Murray, H., & Trist, B. (1993). *The social engagement of social science, volume 2, a Tavistock Anthology-the socio-technical perspective*. Philadelphia: University of Pennsylvania Press.

Unit Perancang Ekonomi. (2021). *Rangka tindakan (blueprint) ekonomi digital Malaysia*. Retrieved from https://www.epu.gov.my/sites/default/files/2021-02/rangka-tindakan-blueprint-ekonomi-digital-Malaysia.pdf

Wilkesmann, M., & Wilkesmann, U. (2018). Industry 4.0 – organizing routines or innovations? *VINE Journal of Information and Knowledge Management Systems*, *48*(2), 238–254.

Yang, F., & Gu, S. (2021). Industry 4.0, is a revolution that requires technology and national strategies. *Complex & Intelligent Systems*, *7*(3), 1311–1325.

Yusuf, R. M., Fidyawan, S., & Wekke, I. S. (2017). Ulrich model on practices of human resource strategic roles. *Journal of Engineering and Applied Sciences*, *12*(6), 1657–1661.

Ziaei Nafchi, M., & Mohelská, H. (2021). Strategic challenges of human resources allocation in Industry 4.0. *Information*, *12*(3), 120.