



CHANGE READINESS AS A PROPOSED DIMENSION FOR INDUSTRY 4.0 READINESS MODELS

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ABSTRACT. Background: Change readiness at organizational level is a key competence needed for Industry 4.0 readiness, and one of the most important critical success factors for managers in implementing Industry 4.0 initiatives.

Methods: This paper conducts a critical literature review of 184 peer-reviewed academic journals and industry reports from 1990 to 2019, and identifies 30 Industry 4.0 readiness models.

Results: A closer review of dimensions from these Industry 4.0 readiness models reveal that change readiness as a model dimension has not been sufficiently addressed. Supporting the conceptualization and operationalization of this new dimension, the literature review in this paper presents six change related dimensions, specifically change commitment factor, change efficacy, change management, individual fear of change, organizational change readiness and change leadership.

Conclusion: This study after critical analysis of the literature proposes change readiness as a new dimension for Industry 4.0 readiness models. Furthermore, in terms of future research, change readiness as a new dimension for studying Industry 4.0 readiness models offers valuable implications for individuals and organizations.

Key words: change readiness, industry 4.0 readiness, fourth industrial revolution, critical analysis, literature review.

INTRODUCTION

Change readiness is a topic that helps in moving organizations from Point A to Point B. It is defined as the state of organization being ready for internal and external changes [Holt, Daspit 2015, Shea et al. 2014]. Change readiness is an important yet an under-studied concept with reference to Industry 4.0 readiness. Industry 4.0 readiness then is defined as the degree to which organizations are able to take advantage of Industry 4.0 technologies [Stentoft et al. 2020]. Hence, this paper considers Change Readiness as a prerequisite for Industry 4.0 readiness, in a way that developing readiness on internal and external changes helps in the preparation for Industry 4.0 readiness. There are different Industry 4.0 readiness models available in the

literature, with various assessment dimensions which will be discussed later in this paper. However, there is a lack of research on studying change readiness as one of the main dimensions for the Industry 4.0 readiness assessment. This review paper hence proposes change readiness as a new dimension for Industry 4.0 readiness models, and justifies its need in the context of Industry 4.0, which is the main motivation for this paper.

The author De Sousa Jabbour highlighted that change readiness at organizational level is a key competence needed for Industry 4.0 readiness, and is an important research gap to be addressed [Jabbour, et al. 2018]. Schneider quotes that change readiness is a critical success factor for managers in implementing Industry 4.0, and hence should be explored further. Change readiness is one of the most

daunting management and leadership task in achieving Industry 4.0 readiness [Schneider 2018]. Moreover, the subject of change readiness is scarcely studied with reference to Industry 4.0 readiness, despite its growing significance for organizations [Jabbour, et al. 2018, Schneider 2018]. The fact that business world is moving fast, and competitive advantage is getting less relevant is all because of the fast rate of change [Hatch 2011]. Change readiness can exist at three levels: individual level, team level and organizational level [Burnes, James 1995]. At individual level, employees in almost all cases create a resistance against it. At team level, team leadership maybe at fault in terms of the communication style or the communication message asking for the change. There is also a leadership gap that people think that they are ready, but they fail to deliver results in the change process. Burnes & James in 1995 observed low change resistance in open and participative teams [Burnes, James 1995]. At organizational level, climate of change is considered. In terms of the scope of this paper, change readiness is considered primarily at the organizational level, as Industry 4.0 readiness model operate on organizational level. Hence the concept of organizational change readiness is considered instead of individual change readiness. This review paper aims at closing these gaps, by proposing change readiness as a new dimension for Industry 4.0 readiness models.

In terms of impact, there are three important perspectives to be considered to understand the relevance of change readiness with Industry 4.0 readiness: political, economic and social impact. From the political perspective, governments are getting more anticipative on trends like Industry 4.0, Fourth Industrial Revolution and Society 5.0, which calls for changes to be done by organizations within, cascading from outside regulators and the government. From the economic perspective Industry 4.0 has immense effect on the micro and macro-economic indicators of the economy, which will then have a direct effect on company performance, and hence organizations need to realign their activities to contribute better towards the economy. Last, from social perspective, organizations have to realign their product and service offerings to

match with the changing needs and wants of customers and consumers. Overall, citizens and communities will tend to be more powerful and will be exercising greater autonomy in making personal choices leading to societal preferences, which then will have substantial effect on organizations. This will change the way we interact with other individuals and organizations. Blockchain, for instance, will enable individuals to do banking on their own without a financial intermediary, swaying direct control of state authorities. On the other side, Industry 4.0 will further increase inequality in society [Bankole et al. 2015]. To address these political, economic and social challenges, developing change readiness for Industry 4.0 technologies is imperative.

The remaining paper is arranged in this sequence: next section presents the review methodology. Subsequently, the section after methodology states the findings, and then the last section concludes this paper with the contributions and the avenues of future research.

RESEARCH METHODOLOGY

A thorough literature search was conducted through four keywords: (a) change readiness, (b) Industry 4.0 readiness model, (c) Industry 4.0 readiness framework, and (d) Industry 4.0 readiness assessment. This resulted in a total of 272 papers extracted from over 13 sources, including Google Scholar, literary databases, Research Gate, Emerald, JSTOR, Sage, MDPI, Science Direct, Wiley, Springer Link, EBSCO Host, Taylor & Francis, Wiley, SCOPUS and Web of Science (WOS). After reading the abstracts individually, 88 articles were excluded as being out of scope, in terms of review objectives. Hence, a total of 184 papers were then analyzed in this review paper. The review methodology followed in this paper is replicable, hence can be updated in the future as the topic of Industry 4.0 readiness and change readiness evolves. The targeted 184 articles, spanned from 1990 to 2019. The concept of Industry 4.0 and Industry 4.0 readiness gained prominence from 2000, but the discussions on change readiness initiated from 1990. For the same reason, this review

starts from 1990 instead of 2000. As majority of the literature exists in English, this review tends to be comprehensive in terms of available literature. Academic journals were given preference, followed by applied journals. Popular and most-cited industry reports and whitepapers have also been considered in this review. 132 (72%) of reviewed articles were quantitative, and the remaining 52 (28%) of articles were qualitative or mixed. The papers that did not provide full model of Industry 4.0 readiness model, or complete items of the questionnaires, or full description of model dimensions have also been counted in this review to ensure comprehensiveness. The highlights of the literature review can be seen in Table 1.

Table 1. Review highlights

| Criterion | Highlights |
|-------------------------|---|
| Total Articles Reviewed | 184 |
| Timeline | 1990 to 2019 |
| Language | English |
| Context | Global (Eastern and Western, including Asian and Non-Asian) |
| Data Extraction | 88 Scientific Journals |
| Keywords | Change readiness, Industry 4.0 readiness model, Industry 4.0 readiness framework, Industry 4.0 readiness assessment |
| Sources | Google Scholar, Literary Databases, Research Gate, Emerald, JSTOR, Sage, MDPI, Science Direct, Wiley, Springer Link, EBSCO Host, Taylor & Francis, Wiley, SCOPUS, WOS |

FINDINGS

The findings from this review paper can be divided into three main sub-sections: change readiness, Industry 4.0 readiness models, and change readiness in the context of Industry 4.0. These findings are individually reiterated in this section.

Change Readiness

Change readiness is defined as the state of organization being ready for internal and external changes [Holt, et al. 2007]. Organizational change also depends on the way it is communicated or marketed in business, which can be in a format that can

create a push or pull for change within an organization [Swanson, Berninger 1996]. There are various studies in the literature that focus on the individual and organizational benefits of developing change readiness. However, change readiness has not been studied extensively in an empirical manner [Weiner et al. 2008]. This section first describes the major findings on change readiness in terms of theoretical and empirical studies, and then it mentions certain change readiness tools and instruments.

Theoretical and Empirical Studies on Change Readiness

The concept of change readiness was first introduced by Jacobson in 1990 [Jacobson 1990]. This word was carried forward by Van De Ven & Poole through a combination of change theories [Van De Ven, Poole 2005]. Change readiness is a multilevel and multifaceted construct (team, department, or organization). So, the statements of 'I' change to 'We' in questions or statements relating to change readiness. The first facet is 'change commitment' that refers to organizational members' resolve to change together. The determinant of this facet is 'change valence' which is how much do the organizational members' value change. The second facet is 'change efficacy' that refers to organizational members' collective capability to change. The determinants of this facet are 'task knowledge', 'resource availability', and 'situational factors' (like timings and environment). Hence, organizational change readiness construct should measure both change commitment and change efficacy.

Moreover, change readiness is a shared psychological state in which organizational members feel committed to implement an organizational change [Weiner 2009]. Here collective behavior is not only advantageous, but necessary. As per some estimates, around 50% of projects fail due to lack of change readiness. Just like Lewin's three-stage model of change, strategists recommend creating readiness by 'unfreezing' the current situation, and then creating motivation to change, and lastly then 'freezing' the changes adopted or implemented. Change implementation like other forms of implementation is seen as

a 'team sport', as issues escalate when some people show commitment and others don't.

Changes motivated in a certain direction show the highest level of change intention. Largely, change readiness is situational, as some organizational features impact more than others. It is interesting to note that correlation is often found in different areas of readiness. At one end, organizational members can be confident to succeed at change yet show less motivation, and the opposite side of that is also probable [Rollnick et al. 1992]. Leadership messages and actions are highly important to generate collective readiness. Organizational processes also have a huge contribution in this regard. Similarly, inconsistent messages derail change process. Change should also resonate well with core values to be durable. This support then is shown by managers, peers, opinion leaders, and senior management. Different people may value organizational change for different reasons. Apart from situational factors, there are various other contextual factors like organizational culture that can amplify or dampen the overall change initiatives [Cattell, Mead 2008].

Contrary to that, Kotter [1999] shared five components that can be applied to variety of change readiness initiatives within the organizations: discrepancy, efficacy, appropriateness, principal support and personal valence. 'Discrepancy' indicates the need of change. The second component 'efficacy' refers to the individual confidence that people have for the results to work for them, as also witnessed by expectancy theory of motivation. The third component 'appropriateness' refers to the agreement or disagreement that an individual might have on change and how convinced he or she is regarding the change in that situation. The fourth component 'principal support' refers to change commitment displayed by the top management, and the promises being made in the process. The fifth and the last component 'personal valence' refers to what's in it for them individually, and the cost benefit analysis individuals can do in their interest.

Moreover, Madsen in 2005 also assessed change readiness for change, but in connection with organizational commitment and social

relationships [Madsen et al. 2005]. The need is of studying individual change readiness for organizational performance. The study findings showed direct and positive relationships between change readiness and organizational commitment. All organizations are continuously changing. Bernerth narrated that in learning organization, employees and the organization act as a single unit [Bernerth 2004]. The research on Human Resource Development (HRD) has been instrumental in this regard. The researchers only in the last decade have progressed on individual employee readiness in an organizational setting [Armenakis et al. 1993]. The problem is not that the change is critical, but it is complex [Swanson & Berninger 1996]. The author used argued that different organizational structures result in different response from individuals on change [Cummings et al. 2016]. Bernerth relates change readiness more with thoughts and intentions [Bernerth 2004]. Backer in 1995 illustrated that change readiness has to do with people's beliefs and attitudes [Backer 1995]. Likewise, majority of the studies consider change readiness as antecedent to resistance or support in people. The study by Riemann in 2016 covers broad developments on the topic of change readiness. The author uses organizational optimization as another word in connection by which organization upgrades itself by change of technology and processes [Riemann 2016]. Change readiness is also seen as a component of project management in certain cases [Gareis 1989].

There are two contemporary approaches on changes readiness: nomadic learning and open innovation. Nomadic learning is an organizational learning concept based on paradigm shift. Nomadic thinking, like an image of rhizome, is critical way of thinking. This is because change no longer is linear, logical and likely. The four ideologies of nomadic learning are: (i) insert as much reality as possible: this implies that there is no industry-academic gap. (ii) incorporate multiple perspectives: this makes collaboration important. (iii) strong interconnection between action and conceptualization: this implies that there should be no gap of doing and becoming, as reality is not separate from conception. and (iv) make the learning horizontal: this implies that no knowledge is complete, and there could

be other horizontal learning areas which are different from your horizontal understanding. Secondly, Verbano analyzed open innovation in small firms, and discovered three unique open innovation profiles [Verbano et al. 2015]. The three open innovation profiles are selective low open, unselective open upstream, and mid-partners integrated open. Christensen in his book 'How Will You Measure Your Life?' encourages companies to be innovative and change ready [Christensen 2015]. He coined this phenomenon as 'innovator's dilemma', concerning about successful firms that can lose ground once the new technologies and changes are in place.

Tools and Instruments on Change Readiness

A learning organization is one in which employees learn and embrace continuous change. The authors Holt and Daspit studied various change readiness instruments, mostly in quantitative methods [Holt et al. 2007]. Despite the inadequacies, the authors suggested that instruments in literature can be combined to create a comprehensive model with four factors: change content, change process, internal context, and individual differences. In other words, readiness for change is affected by the content, the context, the process, and the individuals. Also, readiness is to be studied from cognitively and emotional perspective both. As change is carried by individuals, individual change readiness is an important factor to be studied. The instrument developed can be used before change and after change. This study provided specific factors on readiness.

The study by Solberg devised a new tool for organizational change readiness called the Change Process Capability Questionnaire (CPCQ) [Solberg et al. 2008]. The tool is built to ascertain organizational capability for managing change, which is a slightly different measure from change readiness. Ingersoll et al define organizational capability to manage change as a state of preparedness for change, based on organization's previous history of change, and its future plan to sustain that change. It was also discovered in the research process that organizational culture as a contextual factor is very important for

organizational change. Good evidence-based outcome is required to establish this tool as a guiding tool for change transformation.

An important contribution was made by Bouckennooghe on the topic of organizational change readiness as well [Bouckennooghe et al. 2009]. The author developed a new instrument as Organizational Change Questionnaire, with involvement of Climate of Change, Processes, and Readiness (OCQ-CPR). Climate of change is a word used in company's internal context. The result of the survey resulted in three readiness-for-change dimensions, five climate-of-change dimensions, and three process-of-change dimensions. Organizations are more receptive and open to change than ever, but people are sceptical as always to change [Kotter 1999]. Few validated measures that assess change are by Holt, Armenakis, Harris, & Field. Readiness for change is important along with the process. Previous scales were developed to measure perception instead of attitudes. Other instruments are the Organizational Climate Measure (OCM) by Patterson & Williams and the Readiness for Organizational Change Measure (ROCM) by Holt [Patterson, Williams 2005]. However, issue with the OCM is around organizational climate. Similarly, ROCM is not generalizable. This tool has three angles: emotional dimension of change, cognitive dimension of change, and intentional dimension of change. Hence, readiness is studied as a triadic attitude concept.

Organizational change readiness is crucial for policy implementations [Shea et al. 2014]. However, there are very few research-based methods available to measure this. One of the prominent and recent ones is Organizational Readiness for Implementing Change (ORIC). ORIC measure is based on Weiner's Theory of organizational readiness for change. The study by Shea examined consequences that do not achieve intended results. Organizational readiness is the degree of organizational members' psychological and behavioral preparedness to implement organizational change. High ORIC measure shows that people and organizations are likely to change and hence will cooperate in the change process.

Conversely, low ORIC measure shows that people and organizations are unlikely to change and hence will hurt the change process. In literature review, most focus has been on individual readiness or preparedness, but ORIC measure puts primary focus on organizational change readiness.

Resulting from existing studies, Holt developed a new scale of Individual Readiness for Organizational Change (IROC) [Holt et al. 2007]. The findings suggest that change readiness is dependent on employee perception that (i) they can implement the change (change-specific efficacy), (ii) the change is fit for the organization (appropriateness), (iii) leadership is committed for the change (management support) and (iv) employees will benefit from the change (personal valence). Lewin in 1947 proposed three stages of change as unfreezing, moving, and refreezing. Overall, change readiness assessment can be qualitative (observation and interviews) and quantitative (questionnaires). Qualitative methods provide richer information [Isabella 1990], whereas reliability and validity can be faster established with quantitative methods.

Industry 4.0 Readiness Models

Literature review reveals that there are several existing Industry 4.0 readiness models. The authors Felch & Sucky mentions that there are existing models which don't serve the need

adequately or can be further developed, particularly in terms of business practice [Felch, Sucky 2019]. There has been a quick escalation in the number of Industry 4.0 readiness in the recent few years. Furthermore, these readiness models as self-assessment tools help a company identify its current standing and the change that is necessitated. The comprehensive literature review conducted in this paper as per the methodology explained in the previous section results in 30 different Industry 4.0 readiness models from different academic and industry developers. These models mostly got popular and cited from 2016 onwards, as the area of Industry 4.0 is relatively new. Furthermore, 9 of 30 (30%) of existing Industry 4.0 readiness models were contributed by industry, whereas the remaining 21 of 30 (70%) of existing Industry 4.0 readiness models were contributed by academia. Summary of existing Industry 4.0 readiness models is shown in Table 2. This table is insightful in terms of dimensions, as number and names of dimensions of each model are illustrated juxtapose to the model name. As the table shows, the minimum dimensions used in the models are three, and maximum are 13. Most of the dimensions in different models are similar in names, nature or meaning. However, some dimensions are exclusive and unique to that model and its context only. Next section of this paper, will elaborate more on the dimensions.

Table 2. Existing Industry 4.0 readiness models with dimensions

| S.No. | Model Name | Year | Dimensions Used | Source/ Reference |
|-------|---|------|--|----------------------|
| 1 | Industry 4.0 Readiness Evaluation for Manufacturing Enterprises | 2018 | 8 Dimensions (Strategy, Leadership, Offered product and services, Customers, Company culture, People, Technical aspects (production), Critical areas of intervention) | [Basl & Doucek 2019] |
| 2 | Industry 4.0 Maturity Model | 2018 | 3 Dimensions (Factory of the Future, People & Culture, Strategy) | [Bibby & Dehe 2018] |
| 3 | Future Readiness Level (FRL) / Industry 4.0 Future Readiness | 2018 | 5 Dimensions (Technology Future Readiness Level (TFRL), Event Future Readiness Level (EFRL), Future Thinking Readiness Level (FTRL), Behavior Future Readiness Level (BFRL), Future Readiness Index (FRI)) | [Botha 2018] |
| 4 | E-Business Industry 4.0 Readiness Model | 2018 | 10 Dimensions (Integration of internal processes, use of analytical CRM software, electronic SCM, enterprise sending e-invoices, website with sophisticated functionalities, employees have remote access to IT system, portable devices to more than 20% employees, RFID use, enterprises using social media, cloud computing services) | [Demeter 2018] |
| 5 | Benchmarking Readiness I4.0 | 2018 | 3 Dimensions (Production & operations, digitalization, ecosystem) | Fraunhofer Institute |

| S.No. | Model Name | Year | Dimensions Used | Source/ Reference |
|-------|--|------|---|--|
| 6 | SMEs Maturity Model Assessment of IR4.0 Digital Transformation | 2018 | 7 Dimensions (Strategy & Organization, Smart factory, Vertical & horizontal integration, Distribution control, Smart product, Data driven services, Employees) | [Hamidi et al. 2018] |
| 7 | Readiness for Industry 4.0 | 2018 | 6 Dimensions (Technology, Management & Strategy, Employees & Communication, Organization of Production & Logistics, Interfirm Cooperation, Innovation Ecosystem) | [Horvat et al. 2018] |
| 8 | SSCM Assessment for Industry 4.0 | 2018 | 5 Dimensions (Management strategy & organization, collaboration, sustainable development, technology based smart products, business based smart operations) | [Manavalan & Jayakrishna 2018] |
| 9 | Industry 4.0 Business Model Innovations Tool | 2018 | 3 Dimensions (Value creation, Value offer, Value capture) | [Muller 2018] |
| 10 | Industry 4.0 Maturity Model | 2018 | 7 Dimensions (Digital business model and customer access, Digitalization of product portfolio, Digitizing horizontal and vertical integration of the value chain, Data and analysis as a key capability, Agile IT structure, Complaint handling security law and tax, Organization employees' digital culture) | Pricewaterhouse Coopers |
| 11 | Manufacturing Companies Industry 4.0 Adoption Model | 2018 | 3 Dimensions (strategy, maturity, performance) | [Lin et al. 2018] |
| 12 | BMS Smart Industry Research Roadmap (Behavioral, Management, Social Sciences)- SIRM | 2018 | 4 Dimensions (Technology, Business, Society, People) | University of Twente |
| 13 | ACATECH Industrie 4.0 Maturity Index | 2017 | 4 dimensions (Resources, Information systems, Organizational structure, Culture) | Acatech |
| 14 | Enterprise 4.0 Assessment | 2017 | 7 Dimensions (Structure, Design, Management, Culture, Process, Strategy, Employee Relationships) | [Baicu 2017] |
| 15 | Industry 4.0 Maturity Model- SPICE (Software Process Improvement and Capability dEtermination) | 2017 | 5 dimensions (asset management, data governance, application management, process transformation, organizational alignment) | [Gökalp 2017] |
| 16 | Industry 4.0 Readiness Model for Tool Management | 2017 | 9 Dimensions (Competencies, Database integration, Tool identification, Time horizon of data analytics, Location of data use, Determining the residual tool life, Degree of networking, IT Security, Degree of Standardization) | [Schaupp et al. 2017] |
| 17 | Three Stages Maturity Model in SME's towards Industry 4.0 | 2016 | 3 dimensions (Envision, Enable, Enact) | [Schumacher et al. 2016] |
| 18 | Design Business Modelling for Industry 4.0 | 2016 | 7 Dimensions (Learning & growth perspective, competitiveness perspective, innovation perspective, operational & process level, financial level, strategic level, socio-environmental level) | [Gerlitz 2016] |
| 19 | SIMMI 4.0 – System Integration Maturity Model Industry 4.0 | 2016 | 4 dimensions (Vertical Integration, Horizontal Integration, Cross-sectional Technology Criteria, Digital product development) | [Leyh et al. 2016] |
| 20 | Industry 4.0 Introduction Strategy | 2016 | 3 Dimensions (I4.0 actual analysis, I4.0 target determination, I4.0 implementation) | Merz Consulting |
| 21 | Roadmap Industry 4.0 | 2016 | 13 Dimensions (Acceptance and application of new technology and media, Professional competence, Learning competence, Corporate strategy, HR Development strategy, Organization and democratization, Flexible working models, Health and safety, Information and communication, Employer branding, Change management, Process orientation, Knowledge management) | [Pessl 2017] |
| 22 | Assessment Model for Organizational Adoption of Industry 4.0 Based on Multi-criteria Decision Techniques | 2016 | 6 Dimensions (Products and services, Manufacturing and operations, Strategy and organization, Supply chain, Business model, Legal considerations) | University of Warwick |
| 23 | Industry 4.0 Maturity Model | 2016 | 9 dimensions (Strategy, Leadership, Customers, Products, Operations, Culture, People, Governance, Technology) | [Yagiz Akdil et al. 2018] |
| 24 | Reference Architecture Model for the Industry 4.0 (RAMI4.0) | 2015 | 6 Dimensions (Business, Functional, Information, Communication, Integration, Asset) | [Kannan et al. 2017] |
| 25 | Industry 4.0 Hindering Factors Model | 2015 | 4 Dimensions (Cultural Market Obstructing Factors, Labor Market Obstructing Factors, Organizational Obstructing Factors, Technological Obstructing Factors) | Pricewaterhouse Coopers |
| 26 | IMPULS—Industrie 4.0 Readiness | 2015 | 6 dimensions (Strategy & Organization, Smart Factory, Smart Operations, Smart Products, Data-driven Services, and Employees) | Verband Deutscher Maschinen- und Anlagenbau (VDMA) |

| S.No. | Model Name | Year | Dimensions Used | Source/ Reference |
|-------|--|------|---|-------------------------------------|
| 27 | Industry 4.0 Barometer | 2014 | 3 Dimensions (Strategy, Technology, IT Integration) | MHP (A Porsche Company) |
| 28 | Roland Berger Industry 4.0 Readiness Index | 2014 | Not Specified | Ronald Berger Consulting |
| 29 | Fraunhofer Industrie 4.0 Layer Model | 2013 | 6 Dimensions (Business, Enterprise Transformation, Management, Human Resources, Information & Communication Technology, Production) | Pricewaterhouse Coopers |
| 30 | Industry 4.0 Readiness Model for Manufacturing | 2006 | 7 Dimensions (Strategy, technology, manufacturing & operation, supply chain, employee, product, customer) | [Methavitakul & Santiteerakul 2006] |

Source: Researchers' Own Illustration

Change Readiness in the Context of Industry 4.0

Change management is considered as one of the daunting leadership tasks. To start with, change has long been seen as a three-step process [Cummings et al. 2016]. The first step is called as 'readiness', in which people prepare their mind to support change. The second step is called as 'adoption', in which people are impacted with change. The third and final step is called as 'institutionalization', in which change is reinforced as a practice or habit. The change message in itself and the way it is communicated makes the change an easy or tough call [Armenakis et al. 1993]. The study by Armenakis and Harris focused on how to craft a change message in case the organization is going for change transformation or turnaround [97].

Drawing from literature review, technology readiness has been studied more commonly in the context of Industry 4.0 by Kuo [2013]. However, the subject of change readiness is scarcely studied with reference to Industry 4.0 readiness [Schneider, Castells 2010]. A learning organization is the one that learns, adapts, and changes quickly for accelerated learning, and hence change readiness is important. Kotter shared the perspective of 'efficacy' that can be applied to variety of change management initiatives within the organizations [Kotter 2000]. Efficacy implies the individual confidence that people have for the results to work in the process of change, in a volatile and uncertain environment like Industry 4.0. In similar vein, high organizational readiness for change exceeds job performance. Local needs, opportunities,

and constraints are also important areas to look into before proceeding with the due change(s). This can be used as a base to further research organizational change readiness, rooting from determinants and consequences of change readiness. There are various important questions that are still unanswered like: the impact of different types of changes and types of organizations, readiness being necessary and relevant, readiness threshold to meet before or during change.

The first step for readiness for uncertain conditions (requiring change readiness) and volatile environment (requiring Industry 4.0 readiness) is preparing mind of people to support change (leading to people readiness). The study by Armenakis and Harris focused on how to craft a change message during the transition period (to test process readiness in terms of processes to follow or abandon) in case the organization is going for change transformation or turnaround (in an environment like Industry 4.0) [Armenakis et al. 1993]. The second step for readiness for uncertain conditions (requiring change readiness) and volatile environment (requiring Industry 4.0 readiness) is preparing actions or tasks of people in organizations to implement change (leading to process readiness). Holt and Daspit studied various quantitative readiness instruments, and suggested that readiness for change is impacted by products and services both [Holt & Daspit 2015]. The study by Van De Ven and Poole focused on how innovative products and services (product-service readiness) can pioneer or disrupt the market which is going for change transformation or turnaround (in an environment like Industry 4.0) [Van De Ven & Poole 2005].

The study by Brettel et al. [2014] describe the nine building blocks of business that should be continually changed or improved in the context of Industry 4.0: (i) value proposition: the value of products and services is based on individualizing offerings and accelerating time to market. (ii) customer segments: organizations under influence of Industry 4.0 can change existing and create new markets. (iii) channels: Industry 4.0 enables the seamless use of multiple social media and other online mediums. (iv) customer relationships: collaborative and intensified relations with customers have enabled customer service and customer care. (v) key resources: under Industry 4.0, the most valuable resource for business is value creation networks. (vi) key activities: under Industry 4.0 concepts, customer integration has significant role as customers become co-designers. (vii) key partners: customers are collaborative partners particularly through open source. (viii) revenue streams: physical and digital components work together to realize increased profitability. (ix) cost structure: under Industry 4.0, cost saving potential is immense, as it primarily reduces product and prototype development expenses.

Analyzing the model dimensions individually from all 30 existing Industry 4.0 readiness models as shown Table 2, it reveals that only study by Pessl [2017] has used 'change management' as a change related dimension in their Industry 4.0 readiness model. As shared in the introduction of this paper, change readiness is an important dimension. De Sousa Jabbour highlighted that change readiness at organizational level is a key competence needed for Industry 4.0 readiness, and is an important research gap to be addressed [Lopes de Sousa Jabbour et al. 2018]. Schneider quotes that change readiness is a critical success factor for managers [Schneider 2018]. Moreover, the results of this review paper reflect that the most common dimensions used in these models include dimensions like technology, people, strategy, leadership, processes and innovation. Also, technology as a dimension is used more frequently than other dimensions. It can be seen that change readiness is a new construct for Industry 4.0 readiness models, and for the same reason it is not explored much, as

claimed in some past studies as well. However, the literature review reveals that concepts and constructs related to change readiness are not completely new, and they have been discussed in the literature as model dimensions, but not in the setting of Industry 4.0 readiness models. These change related dimensions with their literature references are listed in Table 3.

Table 3. Change related dimensions from the literature review

| Change Related Dimensions | References |
|---------------------------------|---|
| Change Commitment Factor | [Shea et al., 2014a] |
| Change Efficacy | [Holt et al., 200; Madsen et al., 2005; Shea et al., 2014b] |
| Change Management | [Pessl, 2017] |
| Individual Fear of Change | [Madsen et al., 2005] |
| Organizational Change Readiness | [Lopes de Sousa Jabbour et al., 2018] |
| Change Leadership | [Madsen et al., 2005; Schneider, 2018] |

Source: Researchers' Own Illustration

CONCLUSIONS

Discussing the results presented in the previous section, it is evident that change readiness is an important dimension for Industry 4.0 readiness models. However, out of 30 Industry 4.0 readiness models, only one model by the author Pessl uses change as one of the dimensions [Gabriel, Pessl 2016]. Given the importance of change readiness, it is necessary to give change readiness a more detailed view in connection with Industry 4.0 readiness models. This is also a research gap as identified through this literature review. Therefore, this paper proposes change readiness as a relevant and significant new dimension for Industry 4.0 readiness models for future research. Next, this paper reveals six change related dimensions that can be studied as pertinent dimensions and sub-dimensions in developing the proposed new dimension of change readiness: (a) change commitment factor, (b) change efficacy, (c) change management, (d) individual fear of change, (e) organizational change readiness and (f) change leadership.

In conclusion, change is a highly valuable proposition in the context of Industry 4.0 readiness. Change is by nature episodic, but in Industry 4.0 it has become the norm. So, an

organization needs to be ready for change throughout, and not just on junctures or particular events. This puts immense pressure on organizations to stay relevant in the age of Industry 4.0. Therefore, this paper critically analyses the literature that first shows the importance of exploring change readiness as a new dimension for future research, and then guides on the relevant literature and related dimensions that can be consulted in developing change readiness as a new dimension in Industry 4.0 readiness models.

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ZMIANA GOTOWOŚCI JAK PROPONOWANY WYMIAR MODELU GOTOWOŚCI NA INDUSTRY 4.0

STRESZCZENIE. Wstęp: Gotowość na zmiany na poziomie organizacyjnym jest kluczową kompetencją niezbędną dla gotowości do Industry 4.0 i jedną z najważniejszych krytycznych warunków powodzenia we wdrożeniu inicjatyw związanych z Industry 4.0.

Metody: Praca zawiera krytyczny przegląd publikacji 184 pracy podlegających recenzji z czasopism naukowych oraz raportów przemysłowych z okresu 190-2019 identyfikująca 30 modeli gotowości na Industry 4.0.

Wyniki: Analiza wymiarów modeli gotowości do Industry 4.0 wykazała, że zmiana gotowości, jako wymiar modelu, nie jest wystarczająco adresowana i eksponowana. W celu wspomoczenia zdefiniowania i określenia nowego wymiaru, praca na podstawie dokonanego przeglądu literatury, proponuje zmianę sześciu powiązanych wymiarów, w szczególności współczynnika powiązania, skuteczności zmiany, zarządzania zmianą, indywidualna obawa przed zmianą, gotowość na zmianę organizacyjną oraz kierowanie zmianą.

Wnioski: W wyniku przeprowadzonej krytycznej analizie literatury, zaproponowano zmianą koncepcji gotowości na Industry 4.0 na nowy wymiary modeli gotowości na zmianę na Industry 4.0. Dodatkowo, w kontekście dalszych badań, zmiana gotowości na zmiany, jako nowy wymiar w analizie modeli gotowości na Industry 4.0 oferuje wartościowe konsekwencje dla jednostek jak również organizacji.

Słowa kluczowe: gotowość na zmiany, gotowość na Industry 4.0, czwarta rewolucja przemysłowa, analiza krytyczna, przegląd literatury

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