A Model for Assessing Maturity of Industry 4.0 in the Banking Sector

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Abstract

Recent technological advancements have resulted a paradigm shift in the transition from physical world to a virtual world in many industrial scenarios. Thus, the development of the concept of industry 4.0 revolutionize the way of conducting businesses. The applications of industry 4.0 are rapidly growing in the financial sector as well. As modern customer expectations have risen with the technology improvements, they value relationship centric experience that hinges on trust and personalization while receiving unlimited accessibility, convenience and speed of service. This will challenge banks to deliver their services strategy by enabling advanced technologies. Accordingly, there is an essential need to define, formulate a set of guidelines or a basis for evaluating the progress of the current state of the operational processes of banking sector in the journey of adapting industry 4.0. This study proposes a Maturity Model to assess level of readiness in adapting to industry 4.0 of the banking sector. The proposed maturity model consists of five maturity levels namely: Initial, Managed, Defined, Established and Digital Oriented. The maturity of the bank was assessed based on seven dimensions and its explanatory factors. This scrutiny will provide a comprehensive review of literature in the fields of industry 4.0, its applications in the banking sector and its maturity models.

Keywords
Industry 4.0, Banking 4.0, Maturity Model, Maturity Assessment

1. Introduction
For the last few decades, the emergence of technology plays a major role in increasing the efficiency of an organisation. Since the beginning of the industrialisation, technological dives have created massive changes in the way of performing the businesses, hence in retrospect, these deviations can be defined as industrial revolutions. Thus they evolve from first industrial revolution (*industry 1.0*) as steam power, water power and mechanization to mass production, assembly line and electricity. Then it evolves as third industrial revolution (*industry 3.0*), the introduction of computerization and automation and the fourth is the move towards digitization (Deloitte, 2015). Industry 4.0 is the concept of automation and data exchange in the manufacturing technologies, which enable the use of Internet of Things (IoT), Cyber-Physical Systems (CPS), big data analytics, cloud computing and cognitive computing in order to move towards a smart world (Hercko and Hnat, 2015).

The phenomena industry 4.0 was first introduced in 2011 in Germany as a manufacturing perspective to develop the country's economy (Lu, 2017). Thus, it creates a paradigm shift in the global manufacturing sector by revamping manufacturing operations and processes in order to capture benefits and create values. The dispersion of the concept of industry 4.0 to the service sector was begun recently thus it is being evolved in the financial sector as well. As modern customer expectations have risen with the technology improvements, they value relationship centric experience that hinges on trust and personalization while receiving unlimited accessibility, convenience and speed of service. This will challenge banks to deliver their services strategy in order to survive in the competition. Therefore, banking sector has been integrated the concepts of industry 4.0 into their processes to offer better customer satisfaction.

The development of maturity assessment tools is significant to understand the level of potential of the cyber physical age, regarding any business who applied industry 4.0 concepts/technologies. Accordingly, it is important to assess maturity levels of the banking sector in transition to industry 4.0 concepts / technologies which are essential for continuous improvement. Maturity models provide a comprehensive guidance to define, assess and evaluate the

progress of the current state of the bank in their journey of industry 4.0. Since industry 4.0 is still in its initial stages of development, it is vital to define the structure and methodology for implementation. Therefore, in order to assist organizations which are transforming to the smarter operations, there is a fundamental need to guide them in improving their capabilities. Thus, this study focuses on developing a maturity level assessment model to guide the journey of industry 4.0 in the banking sector. The remainder of this paper is organized as follows: the methodology applied for this study, an overview of research approaches used in the examined articles, the results of the systematic literature review, development of a maturity model and closure of the paper by offering conclusions and an attempt to provide some perspectives on future research.

2. Methodology

Content analysis is the approach employed to capture the state of knowledge in the classified areas. Thus, it enables an investigator to meaningfully interpret and make inferences about the patterns in the content of the overall study (Bowen and Bowen, 2008). The initial step of this study is to comprehensively analyse the literature according to the areas of Industry 4.0, Industry 4.0 applications in the banking sector and maturity models for assessing industry 4.0 maturity levels. Total of 26 articles are analysed in this study based on their relevancy. This study gives an insight into the existing maturity models published in related areas and used it as a basement for developing the proposed maturity assessment model. This is a case study base research which analyses the current state of the banking sector in terms of assessing its maturity in industry 4.0 by application of the developed model. Semi-structured interviews are conducted in order to collect data from the senior managers of the selected banks. Evaluation of maturity is performed by using a standardized questionnaire consisted of closed and open ended questions. Every answer is evaluated using a Likert-scale reaching from 1- "not distinct" to 5- "very distinct'. Based on the results of the study, the future research areas have been proposed.

3. Background of the study
3.1. Industry 4.0

For the last few decades, the emergence of technology plays a major role in increasing the efficiency of an organisation. Since the beginning of the industrialisation, technological dives have created massive changes in the way of performing the businesses, hence in retrospect, these deviations can be defined as industrial revolutions (Wilkesmann and Wilkesmann, 2017).

Starting from first industrial revolution (industry 1.0) as steam power, water power and mechanization, it evolves to mass production, assembly line and electricity. Then it evolves as third industrial revolution (industry 3.0), the introduction of computerization and automation and the fourth is the move towards digitization (Deloitte, 2015). Industry 4.0 is the concept of automation and data exchange in the manufacturing technologies, which enable the use of Internet of Things (IoT), Cyber-Physical Systems (CPS), big data analytics, cloud computing and cognitive computing in order to move towards a smart world (Hercko and Hnat, 2015).

The phenomena industry 4.0 was first introduced in 2011 in Germany as a proposal for the development of a new concept of German economic policy based on high-tech strategies. It is based on the concepts and technologies that include cyber-physical systems, the Internet of things (IoT), and the Internet of services (IoS), Industrial Internet of Things (IIoT), Big Data analytics and etc. These concepts enhance perpetual communication via Internet that allows a continuous interaction and exchange of information not only between humans (C2C) and human and machine (C2M) but also between the machines themselves (M2M) (Roblek et al., 2016).

According to Bruneli et al. (2017) nine tools can be identified as industry 4.0 influencers to the manufacturing sector such as advanced robots, addictive manufacturing, augmented reality, simulation, horizontal and vertical system integration, IIoT, cloud computing, cybersecurity and big data analytics. To capture benefits of the digital technologies, companies need to manage their information architecture effectively as it is critical for their success. In such integration of legacy systems, migrating to the cloud and building cyber resilience is significant. As mentioned by Hercko and Hnat (2015), the successful implementation of industry 4.0 depends on the use of six principles such as interoperability, virtualization, decentralization, capacities in real time, service orientation, modularity and re-configurability.

Agrawal et al. (2017) argues that industry 4.0 can be identified as an emerging platform of technologies which revolutionize the rate of productivity per employee while reducing the cost of controlling and compliance incurred by corporations. According to Berger (2014) industry 4.0 provides flexibility to the production processes thus it helps to create products that are tailored to the target segment while satisfying personalised needs through a low marginal cost. Vaidya et al. discusses about the challenges incorporated with the applications of the industry 4.0 namely, intelligent decision making and negotiation mechanism, high speed networking protocols, manufacturing specific big data and analytics, system modelling and analysis, cyber security, modularized and flexible physical artefacts, investment and etc. Lu (2017) mentions that industry 4.0 creates a value-added integration in horizontally and vertically in the manufacturing processes. Thus horizontal integration was done through value creation modules from the material flow to the logistics of product life cycle, whereas the vertical integration through product, equipment, and human needs with different aggregation levels of the value creation and manufacturing systems.

The fourth industrial revolution which is simply known as Industrial 4.0, creates a new stage in organizing and managing the entire value chain more efficiently. Thus it addresses highly personalized customer requirements while satisfying customers via associated services. The availability of the real time information establishes a basement for value creation, by networking of all related entities in to a single platform with optimal value flow at any time. The optimisation of the association between people, objects with the dynamic, real-time and self-organizing systems can be done through different criteria, such as cost, availability and resource consumption (Wilkesmann and Wilkesmann, 2017).

3.2. Industry 4.0 applications in the banking sector

With the rising expectations of the customers, banking sector is focusing on adapting new technological solutions to automate its processes to offer better customer service. Hence the concept of digital banking emerges. According to Hyman (Fintech Focus), innovation leads to easier customer satisfaction through fully digital reimagining and digitizing banking operations and processes, and improvement in core infrastructure. Digital banking enables the concepts of personalization, accessibility and consistency across devices, connected to customer life events, and enabling intelligent data-driven decision making facilities. Thus it offers application of behavioural economics, predictive analytics, artificial intelligence (AI) and machine learning to anticipate customer needs and get smarter over time about what to offer them rather than being an elegant, consistent interface to customer accounts.

Wilkesmann and Wilkesmann (2017) says that the availability of the real time information establishes a basement for value creation, by networking all related entities in to a single platform with optimal value flow at any time. The association between people, objects, real-time and self-organizing systems are affected by the facts of cost, availability and resource consumption. Hence the use of cloud computing and cyber physical systems is important in banking industry to offer a better customer service. As Wonglimpiyarat (2017) mentions, there are several new innovations in banking landscape like electronic fund transfer at the point-of-sale (EFTPOS), automated teller cash dispenser, internet banking, worldwide interbank financial telecommunication, international electronic fund transfer, Electronic Data Interchange (EDI), mobile banking, Bitcoin wallet, Blockchain banking, crowd funding which provide better customer satisfaction and help to be competitive in the industry.

Cook (2017) says, industry 4.0 innovative technologies like biometric technology help to improve the user experience of banking customers, by providing a simple process to verify existing customers or to enhance KYC (Know Your Customer) on-boarding methods. This will eliminate the use of passbooks, passwords in login or identification purposes in banking system. Customers can create their own set of biometric credentials and then use a combination of this biometrics to log in, verify their accounts and authenticate transactions.

KPMG Banking Systems Survey (2018), mentions about the new industry 4.0 innovation in finance sector which is called, Payment Services Directive II (PSD2). This is likely to become a huge game changer in Banking sector. It is the concept of '*Open Banking*' where, banks will share customer transaction and account data with third parties, including retailers, telco providers, payments services and financial account aggregators. PSD2 will be a trigger to open up the current banking landscape to new players in financial arena, with moving towards new customer experiences, bringing possible disruption to banks. Ratings direct (2018) reveals of the usage of new concepts like "cryptocurrency" in Banking. Cryptocurrencies are digital currencies that use encryption techniques to regulate the generation of units of currency and verify the transfer of funds.

According to Rajan and Kuder (2017), banks use artificial intelligence (AI) to improve customer service by learning from customer behaviour and delivering more precisely on customer preferences in tailoring the customer journey. Thus these technologies can be used to respond customers efficiently via cognitive call centres. The use of these advance technologies will help banks to improve the accuracy of the operations while reducing human errors.

3.3. Industry 4.0 Maturity Models

Maturity model or a framework is a structural approach developed to assist organisations in the journey of industry 4.0 by providing comprehensive guidance while introducing a road map. The term maturity is used to define, assess and form a guideline and a basis for evaluating the progress in a business. The purpose of a Maturity model is to describe the level of perfectness for an entity such as a new business model employed or new software developed. The main idea of a maturity model is to identify the degree of maturity related to different aspects of organisations progress in achieving performance (Gokalp et al., 2017).

According to the literature, several maturity models have been proposed to assess the maturity levels of industry 4.0. Hence most of these models are designed and assessed using manufacturing firms regarding industry 4.0 maturity. Thus application of the concepts to the service sector is very limited. Further analysis of the referenced models is given in Table 1: Analysis of Existing Maturity Models.

According to Suh et al. (2017), maturity of an organisation indicates its internal ability for planning, utilisation and control over the information systems and it is considered as a major advisory factor for the success of the business. Suh et al. (2017) proposed a maturity framework to assess the maturity of an information system. This framework consists of three main dimensions such as IS quality success, IS usage success and IS benefit success. The first dimension, IS quality success is weighted based on system quality, information quality and service quality. The second dimension, IS usage success is weighted based on usage and user satisfaction. The third dimension, IS benefit success is weighted based on operation excellence and strategic positioning.

Schumacher et al. (2016) proposes a model with the purpose of gaining solid data about the current state of the manufacturing companies in order to understand industry 4.0 strategies to extract potential success factors. This model facilitates to evaluate industry 4.0 maturity of an organisation and reflect the fitness of its current strategies. The model consists of nine dimensions where four are used as basic enablers and the rest are used as organisational enablers. The nine dimensions are products, customers, operations, technology, strategy, leadership, governance, culture and people. These dimensions are weighted according to six factors named as utilization of an industry 4.0 roadmap, availability of resources, communication and documentation of industry 4.0 activities, suitability of business models, strategy for digital transformation and alignment of industry 4.0 with company vision. The maturity of each dimension is calculated using weight average thus overall maturity level of the organisation is represented in a radar chart (Schumacher et al., 2016).

As Proenca and Borbinha (2016) mentions, a maturity assessment is essential to measure the current maturity level of a certain aspect of an organization in a meaningful way, through enabling stakeholders to clearly identify strengths and improvement points, and accordingly prioritize what to do in order to reach higher maturity levels. Hence they conducted a literature review to analyse current available models to measure industry 4.0 maturity levels of a firm. The models are being assessed based on the maturity level definitions, number of attributes considered, number of maturity levels and etc.

Pessl et al (2017) develops a model to measure industry 4.0 maturity of a manufacturing firm considering the aspects of purchasing, production, intralogistics, sales and human resource. This model consists of six steps where the maturity assessment is carried out by evaluating the different maturity levels using Microsoft Excel software. The model has three main phases such as analysis, goal setting and implementation. These phases are further divided to six main steps such as general industry 4.0 analysis, a maturity analysis, the determination of the target state, development and evaluation of measures for each field of action, transference of the target objectives and measures to a Balance Scorecard. These six steps are performing sequentially as a road map for industry 4.0 implementation. The model integrates capability maturity model to measure and guide the maturity of the human aspect of the company thus it introduced as Capability Maturity Model Human (CMMH). The Maturity Model consists of five maturity levels where actual and targeted maturity is displayed.

Kim and Grant (2010) proposes a model to measure e-governance maturity using the capability maturity model integration (CMMI). The developed framework is composed of four input areas such as human capital, structural capital, relational capital, and IT investment. Five maturity stages are included in the model accordingly web presence, interaction, transaction, integration, and continuous improvement. These areas are assessed by using the intellectual capital management model and the CMMI model. Intellectual capital management helps practitioners to effectively manage resources, but also auditors to more objectively assess the input area. The CMMI model allows governments to conduct process-based assessments. According to the authors, maturity model is critical to guide organisations over the long term. A maturity model can be identified as a road map that is an important managerial tool when establishing plans, clarifying the scope of e-government activities, allocating resources, monitoring activities, and assessing performance.

The Readiness Model developed by Lichtblau et al. (2015) consists of criteria where companies are classified into three types such as newcomers, learners and leaders. This classification is based on a six key dimensions accordingly smart factory, smart operations, smart products, data-driven services, industry 4.0 based strategy and organization and employees. According to the authors successful implementation of industry 4.0 depends on the six dimensions. The developed assessment model consists of six maturity levels named as Outsider, Beginner, Intermediate, Experienced, Expert, Top performer. The six dimensions are assessed based on the organisations performance and the maturity level of the industry 4.0 implementation is addressed.

Leyh et al. (2016) develops a maturity model to classify the enterprise wide information technology and software landscape focussing on industry 4.0. The developed model was named as SIMMI 4.0 (System Integration Maturity Model Industry 4.0) which facilitates a company to classify its information technology system landscape with focus on Industry 4.0 requirements. The model consists of five stages such as basic digitization level, cross-departmental digitization, horizontal and vertical digitization, full digitization, optimized full digitization. Koska et al. (2017) conduct an empirical survey to measure the maturity of a factory under the concepts of industry 4.0. This study employees a questionnaire to collect data from four industries and assessed them based on their performance in adapting industry 4.0 principles and technologies.

Kermer-Meyer (2017) develops a maturity model to assess industry 4.0 maturity levels of a manufacturing firm. According to the author the factors such as visibility, transparency, predictability and adaptability affect the maturity value of the organisation and they impact the development process as well. The developed model is named as Smart i4.0 Navigator. According to the model the categories of smart solution, smart innovation, smart network, smart production, business model and framework conditions are assessed based on its focussed areas.

Gokalp et al. (2017) proposes a maturity model based on the existing model of Software Process Improvement and Capability Determination (SPICE). The developed model is based on two dimensions such as capability dimension and aspect dimension. Aspect dimension consists of the factors of asset management, data governance, application management, process transformation, and organizational alignment areas. The capability dimension is consisted of six maturity levels starting from 0 to 5 accordingly: incomplete, performed, managed, established, predictable and optimising. Carolis et al. (2017) suggests a maturity model to assess the digital readiness of manufacturing firms. The developed model is based on capability maturity model integration (CMMI) maturity levels. Five areas of a manufacturing firm such as Design and Engineering, Production Management, Quality Management, Maintenance Management, Logistics Management are concerned in the assessment of industry 4.0 maturity level. The five maturity levels (initial, managed, define, integrated and interoperable, digital oriented) are characteristics defined in this study.

Bradley (2014) develops a maturity model to assess industry 4.0 based maturity of an organisation named as the Connected Enterprise Maturity Model. This model consists of 5 maturity levels such as assessment, secure and upgraded network and controls, defined and organised working data capital, analytics, and collaboration. Agca et al. (2017) develops an industry 4.0 readiness assessment tool to measure the maturity of industry 4.0 implementation. This model is comprised of six main dimensions namely; Design and Engineering, Production, Management, Quality Management, Maintenance Management, Logistics Management. The model consists of four maturity levels such as beginner, intermediate, experienced, and expert. This model is mainly focussing on assessing the performance of a manufacturing firm.

3.4. Overview of Maturity Models

Table 1: Analysis of Existing Maturity Models

Maturity Model	Number of Maturity Levels	Number of Dimensions	Maturity Definition	Assessment method described	Continuous Assessment	Focussed field of study	Practicality
IS Maturity Model [Suh et al., 2017]	3	3	Yes	Yes	-	IT Maturity of a firm	General recommendations
I4 Maturity Model [Schumacher et al., 2016]	5	9	No	Yes	Yes	Manufacturing firms' maturity of I4	General recommendations
Roadmap I4 [Pessl et al, 2017]	5	6	Yes	No	-	Manufacturing firms' maturity of I4	General recommendations
E-governance maturity model [Kim and Grant, 2010]	5	2	Yes	No	Yes	E-governance maturity	Specific improvement Activities
I4 Readiness Model [Lichtblau et al., 2015]	6	6	Yes	No	Yes	Manufacturing firms' maturity of I4	Specific improvement Activities
SIMMI 4.0 [Leyh et al., 2016]	5	4	Yes	No	-	IT landscape maturity	General recommendations
Maturity of a factory [Koska et al., 2017]	-	-	-	No	No	Manufacturing firm maturity	-
Smart i4.0 Navigator [Kermer-Meyer, 2017]	4	6	No	No	No	Enterprise maturity of I4	-
SPICE extention [Gokalp et al., 2017]	6	5	Yes	No	Yes	Enterprise maturity of I4	General recommendations
Digital Readiness Assessment [Carolis et al., 2017]	5	5	Yes	No	Yes	Manufacturing Firms I4 maturity	General recommendations
Connected Enterprise Maturity Model [Bradley, 2014]	5	-	Yes	No	Yes	Enterprise maturity of I4	General recommendations
I4 Readiness Assessment Model [Agca et al., 2017]	4	6	Yes	No	Yes	Manufacturing Firms I4 maturity	General recommendations

4. Development of a Maturity Model

According to the literature, several models have been proposed to assess the maturity of industry 4.0 in an organisation thus most of the proposed models are focussing on the manufacturing sector. Hence applicability of the maturity models to the service sector is very limited. Detailed analysis of existing maturity models is given in Table 1. Even though there are several maturity models, still there is a need of improvement in order to best fit for the selected industry. Maturity model or a framework is a structural approach developed to assist organisations in the journey of industry 4.0 by providing comprehensive guidance. The term maturity is used to define, assess and form a guideline and a basis for evaluating the progress in a business. A maturity model consists of major dimensions, which need to be assessed to address the maturity of an organisation in an implementation of a new business model or a software system. Thus it comprises of several maturity levels.

The development of this model consists of four main phases such as concepts understanding, development, implementation and validation. Under the understanding stage, the core concepts of industry 4.0 is analysed through

a comprehensive review of literature. The existing maturity models were further studied and based on the knowledge gained, the structure of the model was designed and developed in the next stage. In the following stages, the model's applicability was tested and validated in a real industrial scenario. The developed maturity model consists of seven dimensions which are further assessed by related criteria. In this study the maturity assessment is done based on the assumption of each dimension is equally important. Table 2 provides an overview of seven dimensions of the maturity model.

Table 2: Maturity Dimensions

Dimension	Explanation
Products and services	Customised products, Digitalised products, Data-driven services, Digital marketing approaches, …
Technology and Resources	Use of advance technologies (PSD II, mobile wallet, mobile Apps, cryptocurrencies, biometric technologies, behavioural analytics through AI and etc.), use of mobile devices, use of cloud technologies….
Strategy and organisation	Implementation I4 roadmap, Available resources for realization, Adaption of business models, organisation culture for innovation, Alignment of I4 with organisational goal….
Operations	Decentralization of processes, Interdisciplinary, Interdepartmental collaboration, Data driven excellence, New digital business models, Equipment readiness for I4…
Customers	Personalised services, Utilization of customer data, Digitalization of services, Customer's Digital media competence, customised Apps…
Governance	Labour regulations for I4, Technology standards, Real time Decision making, Data governance (Data collection, Usage, Data analytics and use of Big Data tools, and Data-driven services), Information Security…
Employees	Knowledge, Expertise and Competences of employees to new technologies, User training, ensure service accuracy…

The proposed model consists of five maturity levels such as initial, managed, defined, established and digital oriented. The definitions of each maturity level are further explained in Table 3.

Table 3: Maturity level definitions

	Maturity Level	Definition
1	Initial	The processes are poorly controlled and process management is reactive. The organization mainly focusing on the fundamental operations that helps to run the business. There is no proper organizational and technological tools and infrastructure to enhance the smooth run of operations.
2	Managed	The process is moderately planned and implemented. The transformation has been started and process management is in considerable level thus limited tools for organization and enabling technologies. Represent a partial maturity in managing the technological infrastructure development. The vision of Industry 4.0 and the idea for a I4 roadmap exists thus it is not fully implemented.
3	Defined	The processes are defined and considerable practices for planning and management procedures are employed. Limited management of the processes due to constraints on technical and resource needs. Practise for integration and interoperability concepts of the information exchange. Data driven services are taken to consideration. The vision of Industry 4.0 and the idea for a I4 roadmap exists thus it is not fully implemented.
4	Established	The vision of Industry 4.0 and the idea for a I4 roadmap is implemented. Key activities, value added operations are well-defined and employed technologies to increase efficiency of the processes respect to best practices in the industry. The processes and operations are considered to be follow standardization. The concepts of integration and interoperability to improve information interchange is highly practised.
5	Digital Oriented	The organisational processes are digitally oriented thus based on a solid technology infrastructure targeting on high potential growth organization. High level of integration of the concepts and principles of I4 thus personalised, data driven service is provided. Collaboration with experts to offer better services. Information, service accuracy is

		guaranteed. Data security is a major concern. Automated, user friendly, customised processes.

The maturity dimensions are assessed using explanatory factors described in Table 2. Each dimension is assessed based on given explanatory factors using a weighted average method with the assumption of each criteria is equally important. Considering the first dimension Products and services, is assessed based on:

C1 :Customised products
C2 :Digitalised products
C3 :Data-driven services
C4 :Digital marketing approaches
C5 :Service-oriented Architecture

Evaluation of maturity through the explanatory criteria is performed by using a standardized questionnaire consisted of closed-ended questions. Semi-structured interviews are conducted to gather data from senior managers of each bank. Every answer is evaluated using a Likert-scale reaching from 1- "not distinct" to 5- "very distinct". Based on the reached value, the maturity dimension is evaluated using a weighted average method. The final maturity level of seven dimensions is presented using a radar chart. Example is given in Figure 1.
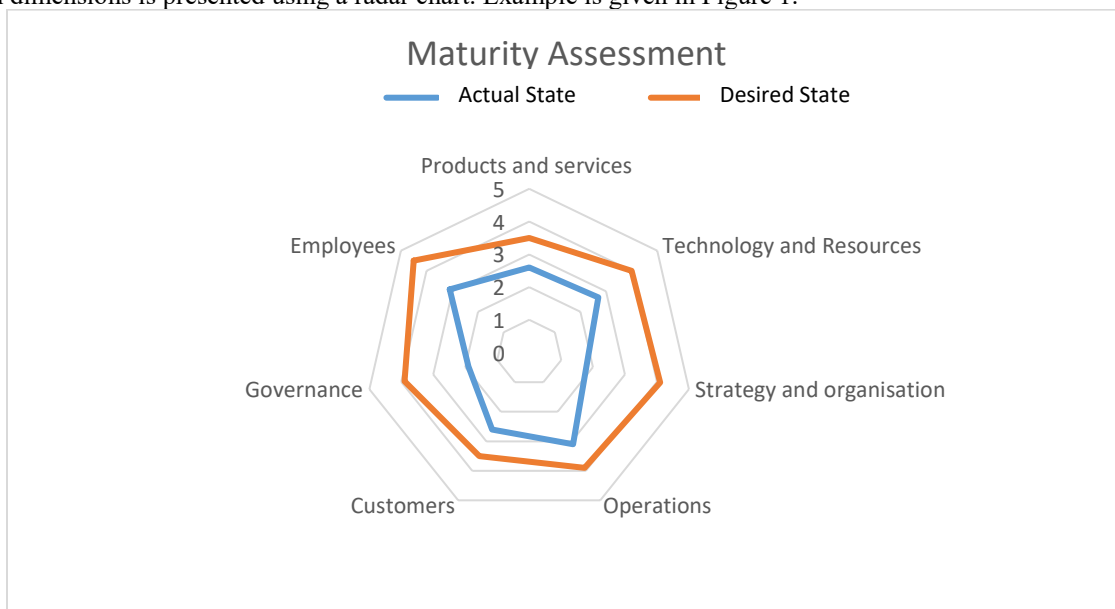

Figure 1: Maturity Level Assessment

The overall maturity level of the organisation is measured using weighted average of the seven maturity dimensions.

5. Conclusion and Future Work

The purpose of this study is to develop and assess a maturity model to understand industry 4.0 maturity level of the banking sector. Thus it acts as a guidance tool over the journey of industry 4.0 adaptation. Assessment of the maturity of industry 4.0 is important for the banking sector in order to identify current capacity as well as opportunities for potential continuous improvements. Thus it is significant to develop a maturity model for the best fit. Even though there are several models proposed to measure maturity levels of industry 4.0, their applications to the service sector is very limited.

According to the literature different authors focussed on measuring the industry 4.0 maturity of an organisation based on different dimensions. The proposed models are consisted of several maturity levels but most of them are not focussing on the characteristics addressed at each level where the organisation needed to follow with the purpose of continuous improvement. Hence it is important to consider how an organisation performs under each dimension of the maturity assessment model to understand the maturity level of industry 4.0, in order to improve the performance to the next maturity level.

Even though organisations who compromise advance technologies to revamp their operations with the purpose of benchmarking with world class performance, it is important to be sustainable. Since Industry 4.0 is still at the early stages of its development, it is essential to clearly define the structure and methodology of implementation guidelines. Therefore, there is a fundamental need to assist organizations which are transforming to the smarter operations in order to guide them for improving their capabilities.

The proposed model of this study is based on the assumption of that all seven maturity dimensions are equally important to measure the maturity of industry 4.0 in the banking sector. Hence the relative importance of each maturity dimension can be further studied in future, based on the applied industry.

6. References

Alaeddin Koska, N. G. (2017). Measuring the Maturity of a Factory for Industry 4.0. *International Journal of Academic Research in Business and Social Sciences, 7*(7).

Anirudh Agrawal, D. S. (n.d.). Incorporating Industry 4.0 in Corporate Strategy.

Anna De Carolis, M. M. (2017). A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies. *IFIP International Federation for Information Processing* (pp. 12-20). Springer.

Berger, R. (2017). *Industry 4.0, New Industrial Revolution hoe Europe will Succeed.* Roland Berger Stretegic Consultants.

Bowen, W., & Bowen, C. (2008). *Content Analysis : Handbook of Research Methods in Public Administration.*

Bradley, A. (2014). *The connected enterprise amaturity model.* USA: Rockwell Automation.

Christian Leyh, T. S. (n.d.). SIMMI 4.0 – A Maturity Model for Classifying the Enterprise-wide IT and Software Landscape Focusing on Industry 4.0. *Federated Conference on Computer Science ans Information Systems* (pp. 1297-1302). FedCSIS.

Cook, S. (2017). *Selfie banking: is it a reality?* Biometric Technology Today.

Diogo Proençaa, J. B. (2016). Maturity Models for Information Systems - A State of the Art. *Conference on Computer Science* (pp. 1042-1049). Science Direct.

Dong-Young Kim, G. G. (2010). E-government maturity model using capability maturity model integration. *Journal of Systems and Information Technology, 12*(3), 230-244.

Ebru Gökalp, U. Ş. (2017). Development of an Assessment Model for Industry 4.0: Industry 4.0-MM.

Ernst Pessl, S. R. (2017). Roadmap Industry 4.0 – Implementation Guideline for Enterprises. *International Journal of Science, Technology and Society*, 193-202.

Hanjun Suh, S. C. (2017). An empirical analysis of a maturity model to assess information system success: a firm-level perspective. *Journal of Behaviour & Information Technology*.

Hercko, J., & Hnat, J. (2015). Industry 4.0- new era of manufacturing. *InvEnt 2015.* Demänovská dolina.

Hyman, G. (n.d.). *Are You a Banker or a Visionary?* Fintech Focus.

(2015). *Industry 4.0 : Challenges and solutions for digital transformation and use of exponential technologies.* Deloitte.

Jacapo Brunelli, V. L. (2017). *Five lessons from the Frontlines of Industry 4.0.* Boston Consultant Group.

Karl Lichtblau, R. B. (2015). *INDUSTRIE 4.0 READINESS.* Aachen, Cologne: Foundation for mechanical engineering,plant engineering, and information technology.

Kermer-Meyer, A. (2017). Industry 4.0 Maturity Assessment. *HANNOVER MESSE.* ResearchGate.

KPMG. (2017/2018). *Technology challenges for Dutch banks in the digital era.* Banking Systems Survey KPMG.

Lu, Y. (2017). Industry 4.0: A survey on technologies, applications and open research Issues. *Journal of Industrial Information Integration, 6*, 1-10.

Onur Agca, J. G. (2017). *An Industry 4 readiness.* Coventry: International Institute for Product and Service Innovation,University of Warwick.

Rajan, S., & Kuder, D. (2017). *How Advances in Machine Intelligence Will Benefit Banks.* FinXtech.

Roblek, V., Mesko, M., & Krapez, A. (2016). A Complex View of Industry 4.0. *SAGE Open*.

Saurabh Vaidya, P. A. (2018). Industry 4.0 - A Glimpse. *2nd International Conference on Materials Manufacturing and Engineering* (pp. 233-238). Elsevier BV.

Schumacher, A., Erol, S., & Sihn, W. (2016). A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises. *Changeable, Agile, Reconfigurable & Virtual Production Conference* (pp. 161-166). Elsevier B.V.

(2018). *The Future Of Banking: Cryptocurrencies Will Need Some Rules To Change The Game.* Ratings Direct.

Wilkesmann, U., & Wilkesmann, M. (2017). Industry 4.0 – organizing routines or innovations? *VINE Journal of Information and Knowledge Management Systems*.

Wonglimpiyarat, J. (2017). FinTech banking industry: a systematic approach. *foresight, 19*(6), 590-603.

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