Critical Success Factors for Implementation of Internet of Things (IoT) in Automotive Companies: A Literature Review

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Abstract

Based on the impact on Indonesian economy, The Ministry of Industry prioritized the automotive industry to be developed. To ensure successful development of manufacturing industry, this research discussed literature review related to Critical Success Factor (CSF) implementation of Industry 4.0 in manufacturing industry. Currently manufacturing industry is required to implement Industry 4.0 to speed up manufacturing process and increase efficiency. The technologies used in Industry 4.0 include big data, cloud computing, internet of things (IoT), 3D Printing, artificial intelligence (AI) and digital manufacturing. The purpose of literature review in this research was to identify Critical Success Factors (CSF) from previous research in implementation of IoT, especially in automotive industry. The results from this research based on literature review before Critical Success Factor (CSF) in IoT implementation were 8 dimensions and 34 sub dimensions. The benefit of literature review is to identify Critical Success Factors (CSF) in implementation of IoT in manufacturing industry, especially in automotive industry.

Keywords

Critical Success Factors, Internet of Things, Automotive Companies, Industry 4.0.

1. Introduction

The implementation of industry 4.0 encourages increased productivity and quality, especially supported by using technology. The implementation of industry 4.0 is an effort to automate and digitize the production process marked by increased connectivity, interaction and boundaries between humans, machines and other resources through information and communication technology. Several industries in the manufacturing sector have implemented industry 4.0, so it is hoped that the industry will grow and become more competitive. The main technologies that drive industrial development 4.0, which are Internet of Things (IoT), Artificial Intelligence (AI), Human – Machine Interface, Robotics and Sensor Technology, and 3D Printing Technology. Some of the challenges that can be generated by the implementation of industry 4.0, include: data security, high levels of stability and reliability in system integration, and reduced human employment (Landherr 2016). In addition, the company still consideres using technology from the cost aspect invested in addition to skilled human resources to be able to operate later because it requires skills for employees to operate.

Industry 4.0 refers to increasing automation, machine-to-machine and human-to-machine communications, artificial intelligence, and continuous technology development. The need for investment in the implementation of Industry 4.0 is based on four driving factors, such as: (1) Increasing data volume, computing power and connectivity; (2) Analytical capabilities and business intelligence; (3) New forms of human-machine interaction,

such as touch interfaces and augmented-reality system; and (4) Development of the transfer of digital instructions into physical forms, such as robotics and 3D printing. Therefore, when countries enter Industry 4.0, comprehensive and sustainable industrial growth tends to occur (Kemenprin 2018).

The manufacturing industry is required to move quickly to keep up with technological developments. The existence of the 4.0 industrial revolution encourages industries, especially large companies to switch to using Cyber-Physical System, Internet of Things, Smart Factory, dan Internet Service (Szozda 2015). In the last three years, Indonesia has been aggressively developing IoT so that the government has encouraged the industry to be able to implement IoT in company business processes (Kemenprin2018). It is necessary to identify and evaluate critical success factors (CSFs) for its implementation (Denolf 2015). This critical success factors provide guidance to the company in determining its business strategy to achieve productivity and efficiency. This research discussed the implementation of IoT in the manufacturing industry by looking at critical success factors (CSFs) in the manufacturing industry, especially in the automotive industry in Indonesia.

2. Critical Success Factors (CSFs) Literature Review in the Implementation of IoT in the Manufacturing Industry

The implementation of IoT in the manufacturing industry considers several factors to determine whether a company can implement IoT. They are consists of business benefit, strategic alignment, business process, operating model changes, capability uplift and end to end security (Peter 2020). This is necessary to support the successful implementation of IoT in company systems.

This research used 14 articles from literature review obtained from several journals discuss about critical success factors (CSFs) in the manufacturing industry so that later they are used as a reference for achieving CSFs that can be applied in the automotive sector in Indonesia. Critical success factors (CSFs) obtained from literature review can be seen in Table 1.

Table1. Comparison of Some Previous Critical Success Factors (CSF) Studies

Number	Researcher	*Critical Success Factors (CSFs)*	Method For Identification and Evaluation (CSFs)
1	(Attaran 2012)	10	X
2	(Denolf et al. 2015)	13	X
3	(Finney and Corbett 2014)	26	X
4	(S. Kumar et al. 2015)	5	AHP
5	(Kiba-Janiak 2016)	26	Delphi Method
6	(Wan and Zeng 2015)	40	Grounded Theory
7	(Talib et al. 2015)	47	Literature Review and Pareto Analysis
8	(Gandhi et al. 2015)	16	DEMATEL
9	(R. Kumar et al. 2012)	11	AHP
10	(Shinohara et al. 2017)	6	Literature Review
11	(Sony M and Naik S 2019)	11	Literature Review
12	(Peter.Klement 2020)	6	X
13	(R. Kumar et al. 2015)	13	Statistic Method
14	(Huang et al. 2019)	79	Delphi Method

Table 1 describes several literature reviews related to critical success factors (CSFs) in implementing IoT and smart devices in manufacturing companies from 2012 to 2020 previous research, where each paper differs in determining critical success factors (CSFs). This is because the characteristics of the company and the target company are different from one company to another in determination of the critical success factors (CSFs) in each company. In addition, there were several papers that did not discuss the identification and evaluation methods after obtaining critical success factors (CSFs), but some did used different methods. The result of the literature review in this research was the obtaining of critical success factors (CSFs). This is important for companies regarding which factors are important when companies implement new technology that will be applied in the company (S.Kumar et

al 2015). The method used to evaluate and identify several methods including literature review, statistics, Dematel, AHP, Grounded Theory and Delphi Method.

3. Results

This research conducted a literature review of 14 previous papers to classify critical success factors (CSFs) and dimensions. The literature review started with the identification of critical success factors (CSFs) and dimensions. Then the analysis and grouping of critical success factors (CSFs) and dimensions were carried out. The results of the literature review critical success factors (CSFs) and dimensions in IoT implementation in the manufacturing industry can be seen in Table 2.

Table 2. Literature Review of Critical Success Factors (CSFs)

Dimension	Source	Critical Success Factors (CSFs)	Source
Marketing	(S. Kumar et al. 2015); (Kiba-Janiak 2016); (Wan and Zeng 2015)	Competition	(S. Kumar et al. 2015); (Wan and Zeng 2015)
		Market requirements	(S. Kumar et al. 2015); (Wan and Zeng 2015)
Regulations	(S. Kumar et al. 2015); (Kiba-Janiak 2016)	Government regulations and authorities	(Kiba-Janiak 2016); (S. Kumar et al. 2015)
People and Management	(S. Kumar et al. 2015); (Kiba-Janiak 2016)); (Wan and Zeng 2015); (Denolf et al. 2015); (Huang et al. 2019)	Top management support and commitment	(Attaran 2012); (Finney and Corbett 2014); (Talib et al. 2015); (Gandhi et al. 2015); (S. Kumar et al. 2015); (Huang et al. 2019);(Sony M and Naik S 2019); (Shinohara et al. 2017)
		Training	(Attaran 2012); (Denolf et al. 2015); (Finney and Corbett 2014); (S. Kumar et al. 2015); (Gandhi et al. 2015); (Huang et al. 2019);(Sony M and Naik S 2019); (Shinohara et al. 2017)
		Effective communication	((Denolf et al. 2015); (Finney and Corbett 2014); (Talib et al. 2015); (Huang et al. 2019); (Shinohara et al. 2017)
		Skilled employees	((Wan and Zeng 2015), (Talib et al. 2015);(Sony M and Naik S 2019); (Shinohara et al. 2017)
Operations	(S. Kumar et al. 2015); (Kiba-Janiak 2016); (Wan and Zeng 2015)	Standardized part numbers	(Talib et al. 2015)
		Clear architecture reference standard for IoT components	(Denolf et al. 2015); (R. Kumar et al.2012); (Shinohara et al. 2017)
		Service flexibility and quality	(Talib et al. 2015); (S.Kumar et al. 2015)

Table 2. Literature Review of Critical Success Factors (CSFs) Continue

Dimension	Source	Critical Success Factors (CSFs)	Source
		Personal privacy invasion	(Talib et al. 2015); (Peter.Klement., 2020)
		Data security	(Denolf et al. 2015); (Wan and Zeng 2015); (Sony M and Naik S 2019); (Shinohara et al. 2017)
Technology	(Wan and Zeng 2015); (Denolf et al. 2015)	Technology standardization approach	(Wan and Zeng 2015); (Denolf et al. 2015), (Talib et al. 2015); (Huang et al. 2019); (S. Kumar et al. 2015)
		Partnership with technology providers	(Attaran 2012); (S. Kumar et al.2015, (Denolf et al. 2015); (Talib et al. 2015); (Shinohara et al. 2017)
Finance	(S. Kumar et al. 2015); (Kiba-Janiak 2016))	System formation cost	(Finney and Corbett 2014); (Shinohara et al. 2017)
		System maintenance cost	(Finney and Corbett 2014); (Shinohara et al. 2017)
		System integration cost	(Gandhi et al. 2015); (Huang et al. 2019); (Shinohara et al. 2017)
		Cost effectiveness and minimization	(S. Kumar et al, 2015; (Talib et al, 2015); (Shinohara et al. 2017)
		Financial situation and factors	(Kiba-Janiak 2016)2016; (Gandhi et al. 2015); (Shinohara et al. 2017)
		Training cost	(S. Kumar et al. 2015); (Huang et al. 2019)
Innovation and Ideas	(Kiba-Janiak 2016)	Readability / Traceability	(S. Kumar et al. 15; (Huang et al. 2019); (Shinohara et al. 2017)
		Compatibility / Functionality / Reliability	(S. Kumar et al. 2015); (Kiba-Janiak 2016)
		Technology and infrastructure integration	(Wan and Zeng 2015); (S. Kumar et al. 2015); (Talib et al. 2015); (Attaran 2012); (Sony M and Naik S 2019); (Shinohara et al. 2017)
		On-time delivery	(Talib et al. 2015); (Wan and Zeng 2015)
		Product quality	(Talib et al. 2015); (Wan and Zeng 2015); (Michael Sony and Subhash Naik 2019)

Table 2. Literature Review of Critical Success Factors (CSFs) Continue

Dimension	Source	Critical Success Factors (CSFs)	Source
		Information quality	(Talib et al. 2015); (Wan and Zeng 2015)
		Customer support	(S. Kumar et al. 2015); (Talib et al. 2015); (Wan and Zeng 2015)
		Work quality	(Attaran 2012); (Talib et al. 2015)
		Ability for trial and observe-ability	(S. Kumar et al. 2015) R. Kumar et al., 2015)
		Equipment interference	(Talib et al. 2015)
		Interoperability and information exchange	(R. Kumar et al., 2015; (Huang et al. 2019); (Shinohara et al. 2017)
Resources	(Kiba-Janiak 2016); (Huang et al. 2019)	Customer focus	(Attaran 2012); (Shinohara et al. 2017)
		Project management	(Finney and Corbett 2014); (Huang et al. 2019); Attaran, 2012; Fui-Hoon Nah et al., 2001;(Sony M and Naik S 2019); (Shinohara et al. 2017)
		Mutual trust	(Talib et al. 2015); (R. Kumar et al. 2015); (Attaran 2012)

After grouping critical success factors (CSFs) and dimensions by conducting a literature review, the next step was to create a framework for critical success factors (CSFs) to determine the rating of critical success factors (CSFs) in automotive industrial companies in Indonesia. These critical success factors are needed so that companies can evaluate their business processes and come up with strategies to improve company performance and productivity. In the era of industrial revolution 4.0, industry is required to be able to reach production targets, and information on production reports can be monitored in real time to anticipate if there are problems and obstacles in the implementation of production. The results of the literature review showed that there are 8 dimensions consisting of marketing, regulations, people and management, operations, technology, finance, innovation and ideas, resources. This research also obtained 34 critical success factors (CSFs). The results of this literature will serve as a framework for this research to conduct validation first and conduct questions and answers with experts to obtain critical success factors (CSFs) used in automotive industrial companies in Indonesia. The framework of critical success factors (CSFs) in implementing IoT in the Indonesian Automotive Industry can be seen in Table 3.

Table 3. Framework Critical Success Factors (CSFs) For the Implementation of IoT in Automotive Industry

Dimension	Key Success Factors
Marketing	Competition
	Market requirements
Regulations	Government regulations and authorities
People and Management	Top management support and commitment
	Training
	Effective communication
	Skilled employees
Operations	Standardized part numbers
	Clear architecture reference standard for IoT components
	Service flexibility and quality
	Personal privacy invasion
	Data security
Technology	Technology standardization approach
	Partnership with technology providers
Finance	System formation cost
	System maintenance cost
	System integration cost
	Cost effectiveness and minimization
	Financial situation and factors
	Training cost
Innovation and Ideas	Readability and Traceability
	Compatibility, Functionality and Reliability
	Technology and infrastructure integration
	On-time delivery
	Product quality
	Information quality
	Customer support
	Work quality
	Ability for trial and observe-ability
	Equipment interference
	Interoperability and information exchange
Resources	Customer focus
	Project management
	Mutual trust

4. Discussion

This research identified and classified critical success factors (CSFs) based on a literature review of previous studies. The grouping resulted in 8 dimensions and 34 critical success factors (CSFs). The results of this literature review still need to go through validation testing using statistical methods to test the relationship between critical success factors (CSFs) and their dimensions, and validation of experts to obtain critical success factors (CSFs) that match the characteristics of manufacturing companies in Indonesia in determining the success of IoT implementation, especially in the automotive industry. The next research stage was to create a questionnaire and determine the number of respondents; in this case, the experts involved had the ability to understand IoT implementation related to the design, architecture and security system of IoT software applied to the automotive industry business processes in Indonesia. The results of the questionnaire, after data processing, obtained ratings of critical success factors (CSFs) in the implementation of IoT in the automotive industry in Indonesia and obtained the right strategy to help companies, especially the automotive industry, determine the success of implementing IoT in companies. In the future, it is expected that automotive industrial companies in Indonesia can follow the era of the industrial revolution 4.0 by using IoT technology in their business processes towards smart manufacturing. Updated technology is needed to speed up business processes and companies benefit from using this technology. This research is expected to provide benefits to researchers who have research interests in the manufacturing sector in determining critical success factors (CSFs) for implementing smart technology that supports business processes in companies in the manufacturing industry.

5. Conclusion

From the results of this research, the researchers had conducted a literature review based on literature review using 14 papers classified based on the name of the researcher, the year published, the number of critical success factors (CSFs), the dimensions of critical success factors (CSFs) and the methods used to identify and evaluate critical success factors (CSFs) related to the implementation of smart technology in the manufacturing industry. In this research, 8 dimensions of critical success factors (CSFs) and 34 critical success factors (CSFs) were obtained which were used as a framework for researchers to determine ratings and strategies for IoT implementation in the manufacturing industry, especially the automotive sector in Indonesia.

The limitation in this research was that there was no validation test related to critical success factors (CSFs) and the research results in the form of a framework critical success factors (CSFs) were only carried out in the manufacturing industry, especially the automotive sector. However, it is hoped that in future research the results of critical success factors (CSFs) can be generalized and applied in various fields related to determining critical success factors (CSFs) in IoT implementation in manufacturing companies. The application of IoT is expected to be a solution for manufacturing companies to become a company with a journey along safety curve that needs to be planned beside that achieve the increasing business value and company capabilities. Some of the challenges of implementing IoT were data security issues, specific human characteristics, robust IoT platforms, data management, need for a high level of stability and reliability in system integration.

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