Critical Success Factors in Digital Transformation for Logistics Service Providers:
A Grey DEMATEL Approach

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Abstract

As innovative digital technologies have become a key competitive weapon in the logistics service industry. Such circumstance has enforced logistics service providers (LSPs) to transform themselves into digital to maintain their competitive advantage. It is therefore essential for LSPs to understand the critical success factors (CSFs) in digital transformation (DT). This study attempts to investigate the causal relationships among CSFs. The logistics service industry in Thailand is used as a case study. Through extensive literature review, nineteen CSFs are identified. The questionnaire is developed to gather data from five qualified industrial experts. Grey DEMATEL approach is deployed to analyze the causal relationship among CSFs and categorize them into cause or effect groups. The finding from this study can help the scholars and practitioners in the field of logistics service to better understand the CSFs of DT and their interrelationships.

Keywords
Digital transformation, Logistics service provider, critical success factors, and Grey DEMATEL

1. Introduction
Adopting Digital Transformation (DT) is currently a big movement in many industries. (Magnusson et al. 2022) as digitalization pushes retailers and related parties to come up with new business model to satisfy the needs of their consumers (Hermann et al. 2020). Especially since COVID-19 that accelerate the disruption which forced the world to go online as government had suspended the physical marketplaces. DT is adopted in business to creating new business model, operation improvement or enhancing customer experiences (Vial 2019) and recently to handle the pandemic. DT is widely spread to all business industry. It creates chain reaction to all stakeholders to adopt DT to maintain the smoothness of operation management. One of the stakeholders that highly involved in most of business is Logistics service providers (LSPs) that plays important roles to manage the flow of tangible goods for businesses. Firms usually hire LSPs to manage the flow of goods so they can focus on their competencies. However, the complexity of DT implementation and the high cost of management has slowdown the success rate of DT in LSPs (Deloitte Southeast Asia Ltd 2021)). From the survey, they discover that only few firms have success their goals with DT, moreover the rate of DT implementation from LSPs is lower compared to other industry. Additionally, the competition among organization tends to get more tense every day. These forces organizations to keep developing themselves to stay competitive and to meet the needs of their customers, otherwise they will lose advantage then fall out of the market. However, adopting DT put pressure on business and operation to keep up with these rapid changes (Rachinger et al. 2019). Therefor the author is interested in study of success factors in digital transformation in order to understand more and be able to help LSPs focus on strengthen their firm.

1.1 Objectives
The research objectives are listed below.
    1. To identify the CSFs in DT for LSPs
    2. To establish the causal relationship between CSFs and prioritize the important barriers in adopting DT

2. Literature Review
2.1 Logistics Service Providers
Logistics activity requires manpower, skills, knowledge, and equipment. It is complex and loaded of details in this operation. Usually, logistics activity is highly costed and require expertise to operate. Most of organization unlikely to take risk in investment for logistics activity as they wish to invest time and funds on focusing on the core competencies (Govindan et al. 2016), therefore LSPs come in to fill this gap to minimize risks and maximize performance for businesses. LSPs are known of the party who managed flows of goods for business and not only they help with challenging activities, but they also push E-commerce business to success (Aphiprachayasakul & Karnjanathaweekul 2019). Logistics service industry has become one of the factors that can drive company or business to gain more competitive advantage. For the perspective of DT, the collected data can distribute significant improvement to LSPs by calculating the route and the time which can be designed from the information given from customers. (Hermann et al. 2020)

2.2 Digital Transformation
From the study from Vial in 2019, the author mentioned that "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies". The changes include the behavior changes of customers and the rising of expectation, the competition in industry also the data analyzing which can be used for further business expansion to target niche customer group. Those changes are the effects from changing society, including the way people immerse use of mobile phone which are internet accessible to use on the digital platform which are convenient for customers as they are able to choose multiples source of channels to deal with their transaction. (Rachinger et al. 2019) Digital Platform requires technology and internet connection; therefore, it caused organization to adjust their strategy for continuing business. The benefits from DT are various in many aspects such as strategic for fulfil customers' needs by integrating new products or services from data collection or strategic for operation efficiency by installing the right technologies to help with the operation which will lead to competitive advantages. DT is one of the enablers that push companies to reduce their complexities and cut the unnecessary processes during the operation and able to be more efficiency (Hermann et al. 2020) or as knowns as Lean Management that focus on value adding process and reduce non-value adding process. (Vanichchinchai 2022)

2.3 Critical Success Factors in Digital Transformation for Logistics Service Providers
From previous studies about DT in LSPs, the success factors are extracted as described below.

2.3.1   C1 Availability of Funds The investment for activities involves with Digital Transformation such as technology installation, skill training for technology expertise ((Deloitte Southeast Asia Ltd 2021), (Sirinarud, et al. 2020) (Deepu & Ravi 2021)

2.3.2   C2 Clear Implementation Plan As Digital transformation is a complex procedure and involves with many stakeholders, therefore a clear implementation plan is necessary to prepare and eliminate the future risks that might happens during the process. (Ghobakhloo & Fathi 2021) (Pfoser et al. 2016) (Ghobakhloo & Iranmanesh 2021)

2.3.3   C3 Digital Strategy Digital strategy is a process of planning g digital transformation use in process of business operation for expanding expertise. A good strategy will help create the differentiation and increase the competitive advantage. There could be a long or a short strategy, performance measurement and it should be compatible with personal in organization as well. (Lipsmeier, et al. 2020), (Deloitte Southeast Asia Ltd 2021), (Aphiprachayasakul & Karnjanathaweekul 2019), (Vial 2019), (Ravimahathanakul 2015), (Sirinarud et al. 2020)

2.3.4   C4 Effective Communication Effective Communication will help personnel understand the main purpose of Digital Transformation implementation and will guide them to see the big picture for this process and clarify the whole process which will increase the collaboration as it will cease worries and frustration. ((Deloitte Southeast Asia Ltd, 2021), (Shakeri & Khalilzadeh 2020), (Vial 2019) (Hermann, et al. 2020)

2.3.5   C5 Employee Engagement Involving employee by creating more engagement will enhance their confident and reduce the fear of losing their jobs from Digital transformation. Listening to the employees' thoughts and ask them to make decision together will support the success of digital transformation. (Deloitte Southeast Asia Ltd, 2021), (Vial 2019) (Abdolvand et al. 2008)

2.3.6   C6 Employee Empowerment Assigning the specialist team to take care of special acts that require skills and experience in process. This decentralization will help the decision making faster and more accurate. (Gupta & Barua, 2018), (Deloitte Southeast Asia Ltd 2021), (Vial 2019))

2.3.7 C7 Goal Clarity Setting goal will reduce tension and conflicts among employees and goal leads people to the same direction. And be able to set a plan to achieve each specific goal. In 2020, (Song & Zhu 2021) there is a study from Song and Zhu, conclude their research as the specific and difficult goals lead to a better performance than a non-specific and easy one. The plan executor will see the goal as the reference and will push themselves to achieve that requirement. From the specific goal, the planner will seek the way to achieve it. (Aggarwal & Srivastava, 2019), (Deloitte Southeast Asia Ltd 2021)

2.3.8 C8 Leadership Team leader will push and motivate their team members. (Vanichchinchai 2023a) This person usually is a decision maker and able to response the problem in time. Their digital literacy should be savvy as they will take responsibility and be a key person in this operation. (Cichosz, et al. 2020), (Deloitte Southeast Asia Ltd 2021), (Vial 2019), (Shakeri & Khalilzadeh 2020)

2.3.9 C9 Long-term Commitment to DT Digital transformation requires consistency and time to work on. It usually takes up to a year to finish. The management should be strong to continue doing digital transformation even it takes longer time to finish. Technology never stops evolving therefore a commitment will helps them keep up with the trend. (Magnusson, et al. 2022) (Deepu & Ravi 2021) (McKinsey&Company 2018) (Raj & Sah, 2019) (Lipsmeier et al. 2020)

2.3.10 C10 Organization Culture Organization that encourages their employees to adapt new challenges to their environment or management that listens to employees to is considered as a positive organization culture (Vanichchinchai 2023b). As a positive organization culture will encourage their employees to try new things and they will be more willing to express their thoughts which will leads to the improvement for the organization. ((Fischer, et al., 2020) (Deloitte Southeast Asia Ltd, 2021), (Vial, 2019) (Sirinarud, et al. 2020) (Shahi & Sinha 2020)

2.3.11 C11 Perception of Readiness to Change Employees with positive thought will embrace changes that coming to their organization. Management should encourage employee to collaborate to digital transformation. This will lead them to understand the needs of change. Reduce doubts, fears of losing jobs and resistance to change. (Cichosz et al. 2020), (Deloitte Southeast Asia Ltd, 2021) (Pfoser et al. 2016)

2.3.12 C12 Performance Measurement Measuring performance to keep track on how's employee doing is a way to prove if the way they operate is on the right track or note. Therefore, they can adjust plan or fix thing in time. (Bag et al. 2020, (Cichosz, et al. 2020), (Aphiprachayasakul & Karnjanathaweekul 2019) (Ravimahathanakul, 2015)

2.3.13 C13 Skillful Employee or Digital Expertise There are many things to learn before changing in organization. There should be person who are be able to rely on to ask for knowledge and guideline. They can transfer this knowledge to other employee to maximize their digital literacy (Fischer, et al. 2020), (Cichosz, et al. 2020), (Shakeri & Khalilzadeh 2020), (Deloitte Southeast Asia Ltd 2021), (Aphiprachayasakul & Karnjanathaweekul, 2019) (Vial, 2019) (Rachinger et al. 2019) (Sirinarud et al. 2020)

2.3.14 C14 Standardization the Process of Work Working with effective standard of procedure reduce complication in work process. Ans a simple process is positive with automation process. (Cichosz et al. 2020), (Ravimahathanakul 2015), (Aphiprachayasakul & Karnjanathaweekul 2019

2.3.15 C15 Top Management Commitment and Understanding Force from management usually strong and effective. Especially when the management state how much they desire to implement of changes. (Shahi et al. 2020) (Sumrit 2019)

2.3.16 C16 Top Management Support Apart from clearer implementation plan from management, showing supports in their process will reminds their employees that they are not alone. Therefore, there will be motivation and more will to continue the work. (Wrede et al. 2020), (Sumrit 2019)

2.3.17 C17 Trust among Employees Trusting among employees will reduce stress and create more friendly environment. (Pigosso & McAloone 2021) , (Shakeri & Khalilzadeh 2020)

2.3.18 C18 Availability of Physical Infrastructure Standard equipment of operation will determine the efficiency of the new equipment usage. The basic infrastructure should be included and able to connect to the new network system. (Pfoser, et al. 2016) , (Deepu & Ravi 2021)

2.3.19 C19 Cyber security Strategies A Plan to secure the confidential data for every stakeholder is necessary in this time of competitive. To minimize the risks from cyber-attack, organization should secure their valuable data to increase more confidents and trust. (Cichosz, et al. 2020), (Vial 2019) (Ravimahathanakul 2015) (Deepu & Ravi 2021)

2.4 Grey DEMATEL

As the combination of Grey theory and DEMATEL method, this will reduce the bias insult as the input of data are from the experience of the group of experts. Grey DEMATEL has been used to analyze in several research, mostly in

finding relationship between factors and understand more of the unknown information. This method aims to identify interrelationship between each factor. According to Wu and Lee, 2007, they mentioned that DEMATEL is the best methodologies for analysis of cause-and-effect relationship in complex structural models and to solve complex problems. (Falatoonitoosi, et al. 2013)

Let x defined a closed and bounded set of real numbers. A grey number $\otimes x$ is an interval with known upper and lower bounds but unknown distribution information for x. Thus, $\otimes x = [\underline{\otimes}x, \overline{\otimes}x] = x \ni'x | \underline{\otimes} x \leq x' \leq \overline{\otimes} x]$, where $\underline{\otimes}x$ and $\overline{\otimes}x$ are the lower and upper bounds of $\otimes x$, respectively, as by Eq. (3).

$$\otimes x = [\underline{\otimes}x, \overline{\otimes}x] = [\acute{x} \in x | \underline{\otimes}x \leq \acute{x} \leq \overline{\otimes} x] \tag{3}$$

The operations of grey number arithmetic are shown by Eqs. (4)-(7).

$$\otimes x_1 + \otimes x_2 = [\underline{x_1} + \underline{x_2}, \overline{x}_1 + \overline{x}_2] \tag{4}$$
$$\otimes x_1 - \otimes x_2 = [\underline{x_1} - \underline{x_2}, \overline{x}_1 - \overline{x}_2] \tag{5}$$
$$\otimes x_1 \times \otimes x_2 = \min(\underline{x_1}\underline{x_2}, \underline{x_1}\overline{x}_2, \overline{x}_1\underline{x_2}, \overline{x}_1\overline{x}_2), \max(\underline{x_1}\underline{x_2}, \underline{x_1}\overline{x}_2, \overline{x}_1\underline{x_2}, \overline{x}_1\overline{x}_2) \tag{6}$$
$$\otimes x_1 \div \otimes x_2 = [\underline{x_1}, \overline{x}_1] \times [\frac{1}{\underline{x_2}}, \frac{1}{\overline{x}_2}] \tag{7}$$

$\otimes x_{ij}^p$ is the grey number for an evaluator p that assess the influence of barrier i on barrier j . $\otimes x_{ij}^p = [\underline{\otimes} x_{ij}^p, \overline{\otimes} x_{ij}^p]$, where $\underline{\otimes} x_{ij}^p$ and $\overline{\otimes} x_{ij}^p$ are the lower and upper bounds of $\otimes x_{ij}^p$, respectively .

Table 1 Linguistic terms in grey DEMATEL

Numeric Scale	Linguistics scale	Grey Scale
0	No influence	0, 0
1	Very Low influence	0, 0.25
2	Low influence	0.25, 0.5
3	High influence	0.5, 0.75
4	Very high influence	0.75, 1

Step 2: Define the grey direct-influence mixed. The linguistics terms in step 1 are converted to grey number. The influence of criteria i on criteria j denoted by $\otimes x_{ij} = [\underline{x}_{ij}, \overline{x}_{ij}]$. To identify the relationship between criteria, the k grey matrices $Z^1, Z^2, \ldots Z^k$ were obtained, as below.

$$Zk = \begin{bmatrix} [0,0] & \otimes x_{12} & \ldots & \otimes x_{1n} \\ \otimes x_{21} & [0,0] & \ldots & \otimes x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \otimes x_{n1} & \otimes x_{n2} & \ldots & [0,0] \end{bmatrix} \tag{8}$$

where $\otimes Z^k$ is the grey direct-influenced matrix, and $\otimes x_{ij} =]\underline{x}_{ij}, \overline{x}_{ij}[$ are the elements in $\otimes Z$. All grey direct-relation matrices Z^k are combined into an aggregate matrix Z, by Eq.(9)

$$Z = \left(\sum_{i=1}^k Z^k\right)/K \tag{9}$$

Step 3 Normalize the grey initial direct-relation matrix $\otimes N$, by Eqs.(10)-(11).

$$s = \max\left(\max_{1\leq i\leq n}\sum_{j=1}^n \overline{x}_{ij}, \max_{1\leq j\leq n}\sum_{i=1}^n \overline{x}_{ij}\right) \tag{10}$$
$$\otimes N = [\otimes n_{ij}]_{n\times n} = [(\underline{n}_{ij}, \overline{n}_{ij}]_{n\times n} = \frac{\otimes Z}{s} \tag{11}$$

where $\otimes N$ is the normalized initial direct-relation matrix, and s is the auxiliary parameter

Step 4 Compute total relation grey matrix $\otimes T$ by Eqs. (12)-(16).

$$\otimes T = [\otimes t_{ij}]_{n\times n} = [(\underline{t}_{ij}, \overline{t}_{ij})]_{n\times n}$$
$$= \otimes N + (\otimes N)^2 + \ldots + (\otimes N)^\infty \tag{12}$$

$$\underline{\otimes}T = [\underline{t}_{ij}]_{n \times n} = \underline{\otimes} N (I - \underline{\otimes} N)^{-1} \tag{13}$$

$$\overline{\otimes}T = [\overline{t}_{ij}]_{n \times n} = \overline{\otimes} N (I - \overline{\otimes} N)^{-1} \tag{14}$$

$$\underline{\otimes}N = [\underline{n}_{ij}]_{n \times n} \tag{15}$$

$$\overline{\otimes}N = [\overline{n}_{ij}]_{n \times n} \tag{16}$$

Within the total-influence matrix *T*, where T = [t$_{ij}$] $_{mxm}$ for *i, j* = 1, 2,...m and *(I-X)(I-X^1)=I*, the sum of rows and columns

are separately represented as vector *r* and *c* by Eqs.(22)-(23).

$$r = (ri)mx1 = [\textstyle\sum_{j=1}^{n} t_{ij}]mx1 \tag{17}$$

$$c = (cj)1x\,m = (cj)'1xm = [\textstyle\sum_{i=1}^{n} t_{ij}]'1xm \tag{18}$$

where superscript ' denotes transposition.

The *r+c* measures the degree of importance of the *i*-th criteria, representing total effects given and received by the *i*-th criteria. The bigger *r+c*, the more important criteria. The prior sequence of *n* criteria is determined by values comparison. For the *(r-c)* is shown the net effect. If *(r-c)>0*, the *i*-th criteria is "caused group". In contrast, if *(r-c)<0*, it is "effect group".

3.   Methods

This study consisted of 2 phased. In phase I, extensive literature review is conducted to extract the critical factors in DT. From this literature review, 19 critical success factors are collected and coded as in 2.3

3.1 Data Collection

The data collection will be performed on a DEMATEL questionnaire based by a group of experts who has experiences in digital transformation. The group comprises of 5 experts who are in Logistics service providers industry, have experience in Digital Transformation for their organization and are in the management level. The sampling size is set according to purposive sampling as the researcher will propose to the respondent directly as the scarcity of experts in the field. The minimum requirement for the number of participants is 5, according to Tongco, 5 sets of data are enough for the accurate results. The experts are asked about their general information and the experiences in DT process. Then they give weigh of influence to other factors to identify the causal relationship among critical success factors which is in phase 2. The framework for methodology is shown in figure 1.
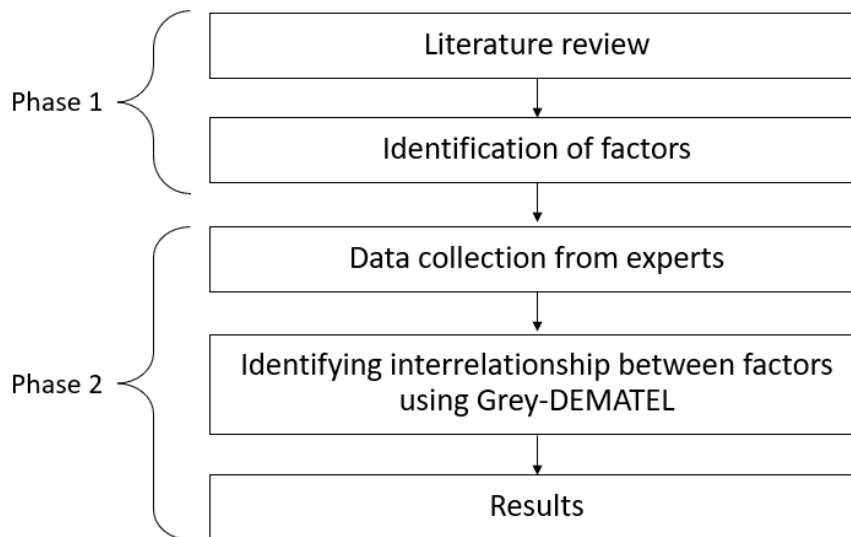

Figure 1. Framework for methodology

4. Results

The collected data are analyzed as approach methods to measure the CSFs. Table 4 shows the average Grey relation matrix for CSFs which are from Grey DEMATEL step 2. Normalized grey direct-influence matrix N was evaluated using Eqs 10-11 as result shown in table 5. Then the total relation matrix was obtained using Eq. 12-16 (table 6.) To Identify group for factors, $r+c$ and $r-c$ are calculated. After calculation of $r+c$ and $r-c$, the results identify those 9 factors are the causal factors ($r+c \geq 0$) and 10 factors are identified as the effects ($r-c \leq 0$). The threshold value is set to help draw digraph is the average value of cause factors group.

The group of cause and effects are shown in figure 2.

4.1 Cause Factors

The factors that influence and affect other factors are Availability of Funds and Financial Investment, Digital strategy, Employee empowerment, Goal Clarity, Leadership, Performance measurement, Top Management commitment and understanding, Top management support, and Availability of existing infrastructure. The most significant factors in this group are Goal Clarity, Digital strategy and followed by Clear implementation plan.

4.2 Effects Factors

As the value from $r-c$ is less than zero, the factor will be identified as a Effects group. This group are the effects are caused by factors mentioned in 5.1. The effect factors are Clear implementation plan, Effective Communication, Employee engagement, Long-term commitment to DP, Organization Culture, Perception of readiness to change, Skillful employee or digital expertise, Standardization the process of work, Trust among Employee, Cyber security strategies

Cause
- Availability of Funds and Financial Investment
- Digital strategy
- Employee empowerment
- Goal Clarity
- Leadership
- Performance measurement
- Top Management commitment and understanding
- Top management support
- Availability of existing infrastructure

Effect
- Clear implementation plan
- Effective Communication
- Employee engagement
- Long-term Commitment to DP
- Organization Culture
- Perception of Readiness to Change
- Skillful employee or digital expertise
- Standardization the process of work
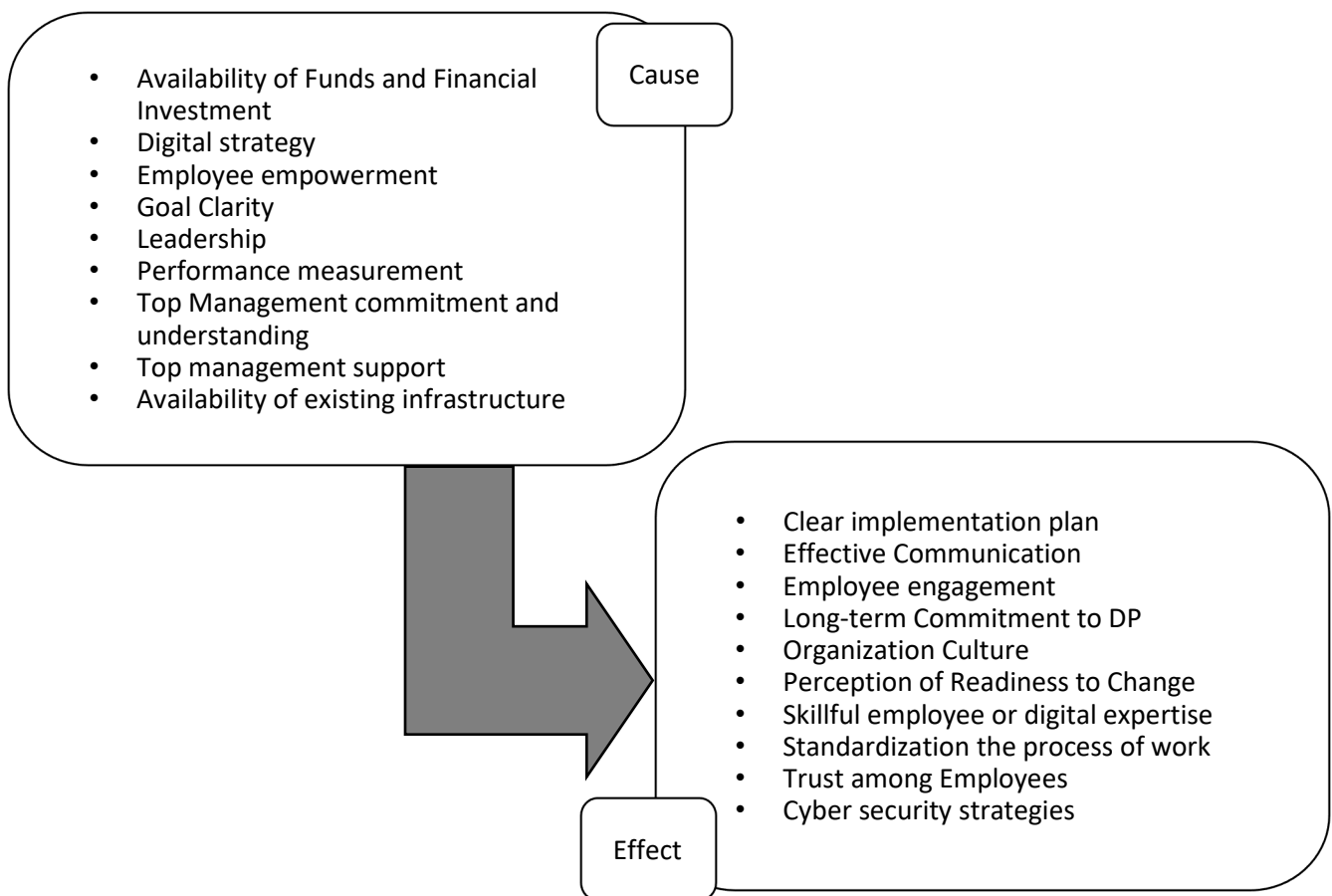- Trust among Employees
- Cyber security strategies

Figure 2. Group of causes and effects

Table 2. Average grey initial direct-relation matrix Z

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
	(0,0)	(0.55,0.8)	(0.6,0.85)	(0.35,0.6)	(0.45,0.7)	(0.25,0.45)	(0.5,0.75)	(0.4,0.65)	(0.6,0.85)	(0.3,0.55)	(0.6,0.85)	(0.45,0.7)	(0.6,0.85)	(0.4,0.6)	(0.45,0.7)	(0.7,0.95)	(0.1,0.3)	(0.45,0.65)	(0.6,0.8)
	(0.7,0.95)	(0,0)	(0.75,1)	(0.75,1)	(0.65,0.9)	(0.4,0.65)	(0.7,0.95)	(0.6,0.85)	(0.75,1)	(0.45,0.7)	(0.5,0.75)	(0.75,1)	(0.45,0.7)	(0.75,1)	(0.45,0.7)	(0.45,0.65)	(0.3,0.5)	(0.45,0.65)	(0.4,0.6)
	(0.7,0.95)	(0.75,1)	(0,0)	(0.75,1)	(0.75,1)	(0.6,0.85)	(0.75,1)	(0.6,0.85)	(0.75,1)	(0.5,0.75)	(0.6,0.85)	(0.75,1)	(0.6,0.85)	(0.75,1)	(0.45,0.7)	(0.45,0.65)	(0.3,0.5)	(0.4,0.6)	(0.55,0.75)
	(0.3,0.55)	(0.7,0.95)	(0.7,0.95)	(0,0)	(0.7,0.95)	(0.5,0.75)	(0.65,0.9)	(0.55,0.8)	(0.55,0.8)	(0.55,0.8)	(0.65,0.9)	(0.5,0.75)	(0.5,0.75)	(0.65,0.9)	(0.45,0.7)	(0.5,0.7)	(0.45,0.65)	(0.2,0.35)	(0.4,0.6)
	(0.15,0.4)	(0.55,0.8)	(0.5,0.75)	(0.65,0.9)	(0,0)	(0.7,0.95)	(0.55,0.8)	(0.55,0.8)	(0.6,0.85)	(0.55,0.8)	(0.7,0.95)	(0.65,0.9)	(0.7,0.95)	(0.6,0.85)	(0.3,0.55)	(0.4,0.65)	(0.65,0.9)	(0.15,0.35)	(0.4,0.65)
	(0.15,0.35)	(0.55,0.8)	(0.55,0.8)	(0.6,0.85)	(0.75,1)	(0,0)	(0.55,0.8)	(0.55,0.8)	(0.75,1.0)	(0.6,0.85)	(0.65,0.9)	(0.55,0.8)	(0.5,0.75)	(0.55,0.8)	(0.45,0.7)	(0.55,0.8)	(0.6,0.85)	(0.2,0.4)	(0.5,0.75)
	(0.75,1)	(0.75,1)	(0.75,1)	(0.65,0.9)	(0.65,0.9)	(0.6,0.85)	(0,0)	(0.55,0.8)	(0.75,1.0)	(0.5,0.75)	(0.6,0.85)	(0.75,1)	(0.55,0.8)	(0.6,0.85)	(0.6,0.85)	(0.7,0.95)	(0.45,0.7)	(0.4,0.65)	(0.55,0.8)
	(0.45,0.7)	(0.6,0.85)	(0.55,0.8)	(0.6,0.85)	(0.65,0.9)	(0.5,0.7)	(0.6,0.85)	(0,0)	(0.6,0.85)	(0.6,0.85)	(0.55,0.8)	(0.65,0.9)	(0.6,0.85)	(0.6,0.85)	(0.6,0.85)	(0.6,0.85)	(0.55,0.8)	(0.45,0.7)	(0.45,0.7)
	(0.6,0.85)	(0.75,1)	(0.7,0.95)	(0.55,0.8)	(0.65,0.9)	(0.55,0.8)	(0.7,0.95)	(0.65,0.9)	(0,0)	(0.55,0.8)	(0.55,0.8)	(0.45,0.7)	(0.4,0.65)	(0.6,0.85)	(0.55,0.8)	(0.65,0.9)	(0.4,0.65)	(0.25,0.45)	(0.4,0.65)
	(0.2,0.4)	(0.6,0.85)	(0.5,0.75)	(0.6,0.85)	(0.6,0.85)	(0.65,0.9)	(0.5,0.75)	(0.55,0.8)	(0.6,0.85)	(0,0)	(0.65,0.9)	(0.4,0.65)	(0.35,0.6)	(0.45,0.7)	(0.55,0.8)	(0.55,0.8)	(0.6,0.85)	(0.15,0.35)	(0.25,0.5)
	(0.4,0.6)	(0.65,0.9)	(0.45,0.7)	(0.65,0.9)	(0.6,0.85)	(0.65,0.9)	(0.6,0.85)	(0.6,0.85)	(0.55,0.8)	(0.55,0.8)	(0,0)	(0.4,0.65)	(0.5,0.75)	(0.5,0.75)	(0.6,0.85)	(0.65,0.9)	(0.6,0.85)	(0.4,0.6)	(0.5,0.75)
	(0.4,0.65)	(0.75,1)	(0.7,0.95)	(0.6,0.85)	(0.75,1)	(0.65,0.9)	(0.75,1)	(0.65,0.9)	(0.6,0.85)	(0.55,0.8)	(0.6,0.85)	(0,0)	(0.6,0.85)	(0.65,0.9)	(0.45,0.7)	(0.6,0.85)	(0.55,0.8)	(0.2,0.45)	(0.55,0.8)
	(0.5,0.75)	(0.6,0.85)	(0.5,0.75)	(0.5,0.75)	(0.6,0.85)	(0.35,0.6)	(0.6,0.85)	(0.55,0.8)	(0.5,0.75)	(0.4,0.65)	(0.5,0.75)	(0.6,0.85)	(0,0)	(0.75,1)	(0.25,0.5)	(0.25,0.45)	(0.45,0.65)	(0.4,0.6)	(0.4,0.6)
	(0.15,0.3)	(0.7,0.95)	(0.7,0.95)	(0.6,0.85)	(0.6,0.85)	(0.4,0.65)	(0.55,0.8)	(0.6,0.85)	(0.65,0.9)	(0.55,0.8)	(0.45,0.7)	(0.5,0.75)	(0.7,0.95)	(0,0)	(0.15,0.3)	(0.15,0.35)	(0.4,0.65)	(0.15,0.35)	(0.5,0.75)
	(0.55,0.8)	(0.7,0.95)	(0.65,0.9)	(0.6,0.85)	(0.5,0.75)	(0.6,0.85)	(0.75,1)	(0.6,0.85)	(0.6,0.85)	(0.6,0.85)	(0.7,0.95)	(0.6,0.85)	(0.45,0.7)	(0.4,0.6)	(0,0)	(0.65,0.9)	(0.3,0.5)	(0.5,0.75)	(0.55,0.8)
	(0.65,0.9)	(0.55,0.8)	(0.7,0.95)	(0.65,0.9)	(0.6,0.85)	(0.7,0.95)	(0.75,1)	(0.65,0.9)	(0.7,0.95)	(0.65,0.9)	(0.75,1)	(0.55,0.8)	(0.5,0.75)	(0.75,1.0)	(0,0)	(0.45,0.65)	(0.5,0.75)	(0.6,0.85)	(0.6,0.85)
	(0.05,0.2)	(0.3,0.5)	(0.15,0.35)	(0.6,0.85)	(0.65,0.9)	(0.6,0.85)	(0.4,0.65)	(0.55,0.8)	(0.45,0.7)	(0.6,0.85)	(0.55,0.8)	(0.35,0.6)	(0.4,0.6)	(0.45,0.7)	(0.35,0.6)	(0.3,0.5)	(0,0)	(0.1,0.3)	(0.35,0.6)
	(0.45,0.7)	(0.4,0.65)	(0.6,0.85)	(0.3,0.55)	(0.35,0.6)	(0.25,0.5)	(0.4,0.65)	(0.5,0.75)	(0.4,0.65)	(0.45,0.7)	(0.6,0.85)	(0.25,0.5)	(0.35,0.6)	(0.45,0.7)	(0.35,0.6)	(0.35,0.6)	(0.25,0.45)	(0,0)	(0.7,0.95)
	(0.6,0.85)	(0.55,0.8)	(0.6,0.85)	(0.3,0.55)	(0.3,0.55)	(0.3,0.55)	(0.4,0.65)	(0.3,0.55)	(0.3,0.55)	(0.3,0.55)	(0.35,0.6)	(0.15,0.4)	(0.25,0.5)	(0.25,0.5)	(0.45,0.7)	(0.45,0.7)	(0.35,0.6)	(0.55,0.8)	(0,0)

Table 3. Normalized grey direct-influence matrix N

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
	(0,0)	(0.03,0.07)	(0.04,0.07)	(0.02,0.05)	(0.03,0.06)	(0.02,0.04)	(0.03,0.07)	(0.03,0.06)	(0.04,0.07)	(0.02,0.05)	(0.04,0.07)	(0.03,0.06)	(0.04,0.07)	(0.03,0.05)	(0.03,0.06)	(0.04,0.08)	(0.01,0.03)	(0.03,0.06)	(0.04,0.07)
	(0.04,0.08)	(0,0)	(0.05,0.09)	(0.05,0.09)	(0.04,0.08)	(0.03,0.06)	(0.04,0.08)	(0.04,0.07)	(0.05,0.09)	(0.03,0.06)	(0.03,0.07)	(0.05,0.09)	(0.03,0.06)	(0.05,0.09)	(0.03,0.06)	(0.03,0.06)	(0.02,0.04)	(0.03,0.06)	(0.03,0.05)
	(0.04,0.08)	(0.05,0.09)	(0,0)	(0.05,0.09)	(0.05,0.09)	(0.04,0.07)	(0.05,0.09)	(0.04,0.07)	(0.05,0.09)	(0.03,0.07)	(0.04,0.07)	(0.05,0.09)	(0.04,0.07)	(0.05,0.09)	(0.03,0.06)	(0.03,0.06)	(0.02,0.04)	(0.03,0.05)	(0.03,0.07)
	(0.02,0.05)	(0.04,0.08)	(0.04,0.08)	(0,0)	(0.04,0.08)	(0.03,0.07)	(0.04,0.08)	(0.03,0.07)	(0.03,0.07)	(0.03,0.07)	(0.04,0.08)	(0.03,0.07)	(0.03,0.07)	(0.04,0.08)	(0.03,0.06)	(0.03,0.06)	(0.03,0.06)	(0.01,0.03)	(0.03,0.05)
	(0.01,0.03)	(0.03,0.07)	(0.03,0.07)	(0.04,0.08)	(0,0)	(0.04,0.08)	(0.03,0.07)	(0.03,0.07)	(0.04,0.07)	(0.03,0.07)	(0.04,0.08)	(0.04,0.08)	(0.04,0.07)	(0.02,0.05)	(0.03,0.06)	(0.04,0.07)	(0.01,0.03)	(0.03,0.06)	(0.03,0.06)
	(0.01,0.03)	(0.03,0.07)	(0.03,0.07)	(0.04,0.07)	(0.05,0.09)	(0,0)	(0.03,0.07)	(0.03,0.07)	(0.05,0.09)	(0.04,0.07)	(0.04,0.08)	(0.03,0.07)	(0.03,0.07)	(0.04,0.07)	(0.03,0.06)	(0.03,0.07)	(0.04,0.07)	(0.01,0.03)	(0.03,0.06)
	(0.05,0.09)	(0.05,0.09)	(0.05,0.09)	(0.04,0.08)	(0.04,0.08)	(0.04,0.07)	(0,0)	(0.03,0.07)	(0.05,0.09)	(0.03,0.07)	(0.04,0.07)	(0.05,0.09)	(0.03,0.07)	(0.04,0.07)	(0.04,0.07)	(0.04,0.08)	(0.03,0.06)	(0.03,0.06)	(0.03,0.07)
	(0.03,0.06)	(0.04,0.07)	(0.03,0.07)	(0.04,0.07)	(0.04,0.08)	(0.03,0.06)	(0.04,0.07)	(0,0)	(0.04,0.07)	(0.04,0.07)	(0.03,0.07)	(0.04,0.08)	(0.04,0.07)	(0.04,0.07)	(0.04,0.07)	(0.04,0.07)	(0.03,0.07)	(0.03,0.06)	(0.03,0.06)
	(0.04,0.07)	(0.05,0.09)	(0.04,0.08)	(0.03,0.07)	(0.04,0.08)	(0.03,0.07)	(0.04,0.08)	(0.04,0.08)	(0,0)	(0.03,0.07)	(0.03,0.07)	(0.03,0.06)	(0.03,0.06)	(0.04,0.07)	(0.03,0.07)	(0.04,0.08)	(0.03,0.06)	(0.02,0.04)	(0.03,0.06)
	(0.01,0.03)	(0.04,0.07)	(0.03,0.07)	(0.04,0.07)	(0.04,0.07)	(0.04,0.08)	(0.03,0.07)	(0.03,0.07)	(0.04,0.07)	(0,0)	(0.04,0.08)	(0.03,0.06)	(0.02,0.05)	(0.03,0.06)	(0.03,0.07)	(0.03,0.07)	(0.04,0.07)	(0.01,0.03)	(0.02,0.04)
	(0.03,0.05)	(0.04,0.08)	(0.03,0.06)	(0.04,0.08)	(0.04,0.07)	(0.04,0.08)	(0.04,0.07)	(0.04,0.07)	(0.03,0.07)	(0.03,0.07)	(0,0)	(0.03,0.06)	(0.03,0.07)	(0.03,0.07)	(0.04,0.07)	(0.04,0.08)	(0.04,0.07)	(0.03,0.05)	(0.03,0.07)
	(0.03,0.06)	(0.05,0.09)	(0.04,0.08)	(0.04,0.07)	(0.05,0.09)	(0.04,0.07)	(0.05,0.09)	(0.04,0.08)	(0.04,0.07)	(0.03,0.07)	(0.04,0.07)	(0,0)	(0.04,0.07)	(0.05,0.09)	(0.02,0.04)	(0.02,0.04)	(0.03,0.06)	(0.01,0.04)	(0.03,0.07)
	(0.01,0.03)	(0.04,0.08)	(0.04,0.08)	(0.04,0.07)	(0.04,0.07)	(0.03,0.06)	(0.03,0.07)	(0.04,0.07)	(0.04,0.08)	(0.03,0.07)	(0.03,0.06)	(0.03,0.07)	(0,0)	(0.01,0.03)	(0.01,0.03)	(0.03,0.06)	(0.01,0.03)	(0.03,0.07)	(0.03,0.05)
	(0.03,0.07)	(0.04,0.08)	(0.04,0.08)	(0.04,0.07)	(0.03,0.07)	(0.04,0.07)	(0.05,0.09)	(0.04,0.07)	(0.04,0.07)	(0.04,0.07)	(0.04,0.08)	(0.04,0.07)	(0.03,0.06)	(0,0)	(0.03,0.05)	(0.04,0.08)	(0.02,0.04)	(0.03,0.07)	(0.03,0.07)
	(0.03,0.07)	(0.04,0.08)	(0.04,0.08)	(0.04,0.07)	(0.03,0.07)	(0.04,0.07)	(0.05,0.09)	(0.04,0.07)	(0.04,0.07)	(0.04,0.07)	(0.04,0.08)	(0.04,0.07)	(0.03,0.06)	(0.03,0.05)	(0,0)	(0.04,0.08)	(0.02,0.04)	(0.03,0.07)	(0.03,0.07)
	(0.04,0.08)	(0.03,0.07)	(0.04,0.08)	(0.04,0.08)	(0.04,0.07)	(0.04,0.08)	(0.05,0.09)	(0.04,0.08)	(0.04,0.08)	(0.04,0.08)	(0.05,0.09)	(0.05,0.09)	(0.03,0.07)	(0.03,0.07)	(0.05,0.09)	(0,0)	(0.03,0.06)	(0.03,0.07)	(0.04,0.07)
	(0,0.02)	(0.02,0.04)	(0.01,0.03)	(0.04,0.07)	(0.04,0.08)	(0.04,0.07)	(0.03,0.06)	(0.03,0.07)	(0.03,0.06)	(0.04,0.07)	(0.03,0.07)	(0.02,0.05)	(0.03,0.05)	(0.03,0.06)	(0.02,0.04)	(0.02,0.04)	(0,0)	(0.01,0.03)	(0.02,0.05)
	(0.03,0.06)	(0.03,0.06)	(0.04,0.07)	(0.02,0.05)	(0.02,0.05)	(0.02,0.04)	(0.03,0.06)	(0.03,0.07)	(0.03,0.06)	(0.03,0.06)	(0.04,0.07)	(0.02,0.04)	(0.02,0.05)	(0.03,0.06)	(0.02,0.05)	(0.02,0.05)	(0.02,0.04)	(0,0)	(0.04,0.08)
	(0.04,0.07)	(0.03,0.07)	(0.04,0.07)	(0.02,0.05)	(0.02,0.05)	(0.02,0.05)	(0.03,0.06)	(0.02,0.05)	(0.02,0.05)	(0.02,0.05)	(0.02,0.05)	(0.01,0.03)	(0.02,0.04)	(0.02,0.04)	(0.03,0.06)	(0.03,0.06)	(0.02,0.05)	(0.03,0.07)	(0,0)

Table 4. Grey total influence matrix T

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
C1	0.21	0.29	0.32	0.25	0.27	0.25	0.29	0.28	0.31	0.27	0.32	0.31	0.37	0.28	0.37	0.42	0.27	0.48	0.40
C2	0.40	0.12	0.30	0.30	0.27	0.25	0.29	0.28	0.30	0.26	0.24	0.33	0.27	0.32	0.30	0.27	0.27	0.41	0.27
C3	0.37	0.28	0.12	0.29	0.28	0.28	0.28	0.26	0.28	0.25	0.25	0.31	0.29	0.30	0.28	0.26	0.25	0.37	0.29
C4	0.30	0.30	0.31	0.12	0.30	0.30	0.29	0.29	0.27	0.31	0.30	0.29	0.30	0.32	0.32	0.31	0.34	0.35	0.29
C5	0.25	0.26	0.25	0.30	0.11	0.35	0.27	0.29	0.28	0.31	0.31	0.32	0.36	0.30	0.28	0.29	0.41	0.34	0.30
C6	0.24	0.26	0.26	0.28	0.31	0.13	0.26	0.28	0.31	0.32	0.29	0.29	0.29	0.28	0.32	0.32	0.39	0.35	0.32
C7	0.37	0.28	0.28	0.26	0.26	0.27	0.13	0.24	0.28	0.24	0.25	0.30	0.26	0.26	0.31	0.32	0.29	0.37	0.29
C8	0.32	0.26	0.25	0.27	0.27	0.27	0.26	0.11	0.26	0.30	0.25	0.30	0.30	0.28	0.34	0.32	0.35	0.42	0.29
C9	0.37	0.29	0.29	0.26	0.27	0.29	0.29	0.29	0.11	0.29	0.26	0.25	0.25	0.28	0.33	0.34	0.31	0.35	0.28
C10	0.28	0.29	0.27	0.31	0.29	0.36	0.27	0.30	0.30	0.14	0.32	0.27	0.28	0.28	0.37	0.35	0.42	0.36	0.27
C11	0.31	0.27	0.23	0.29	0.27	0.32	0.27	0.29	0.26	0.30	0.11	0.24	0.29	0.26	0.35	0.34	0.38	0.41	0.32
C12	0.29	0.28	0.28	0.26	0.28	0.30	0.28	0.28	0.25	0.27	0.25	0.11	0.29	0.28	0.30	0.33	0.33	0.33	0.30
C13	0.39	0.30	0.28	0.29	0.30	0.28	0.30	0.31	0.28	0.29	0.28	0.34	0.15	0.37	0.29	0.26	0.37	0.45	0.32
C14	0.28	0.34	0.35	0.33	0.31	0.31	0.30	0.34	0.33	0.35	0.28	0.32	0.40	0.14	0.26	0.24	0.38	0.38	0.37
C15	0.35	0.28	0.27	0.26	0.23	0.29	0.29	0.27	0.26	0.29	0.29	0.28	0.26	0.22	0.14	0.33	0.26	0.44	0.31
C16	0.34	0.24	0.27	0.26	0.25	0.29	0.28	0.26	0.27	0.28	0.28	0.29	0.26	0.23	0.34	0.12	0.27	0.40	0.30
C17	0.29	0.27	0.24	0.39	0.39	0.43	0.31	0.38	0.33	0.43	0.37	0.33	0.36	0.36	0.37	0.35	0.26	0.41	0.38
C18	0.43	0.28	0.35	0.27	0.27	0.29	0.29	0.34	0.29	0.35	0.35	0.28	0.33	0.33	0.37	0.35	0.35	0.32	0.47
C19	0.50	0.34	0.37	0.29	0.27	0.32	0.31	0.30	0.28	0.33	0.30	0.27	0.32	0.29	0.42	0.40	0.40	0.58	0.23

Table 5. Crisp Value Q

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
C1	0.11	**0.29**	**0.30**	0.22	0.25	0.19	**0.27**	0.24	**0.29**	0.20	**0.29**	0.25	**0.29**	0.23	0.25	**0.32**	0.14	0.25	**0.29**
C2	**0.32**	0.16	**0.36**	**0.35**	**0.33**	0.25	**0.34**	**0.31**	**0.36**	0.26	**0.28**	**0.34**	0.26	**0.35**	0.25	0.26	0.21	0.24	0.24
C3	**0.33**	**0.37**	0.17	**0.36**	**0.37**	**0.31**	**0.36**	**0.31**	**0.36**	0.28	**0.32**	**0.35**	**0.31**	**0.36**	0.25	0.26	0.21	0.23	**0.28**
C4	0.21	**0.34**	**0.33**	0.13	**0.34**	0.27	**0.32**	0.29	**0.30**	0.28	**0.32**	0.27	0.27	**0.32**	0.25	0.27	0.25	0.17	0.23
C5	0.16	**0.29**	0.27	**0.32**	0.14	**0.32**	**0.29**	0.28	**0.30**	0.28	**0.33**	**0.31**	**0.32**	**0.30**	0.20	0.24	**0.31**	0.15	0.23
C6	0.16	**0.30**	**0.29**	**0.31**	**0.35**	0.12	**0.29**	0.29	**0.35**	**0.30**	**0.32**	0.28	0.26	**0.29**	0.25	**0.28**	**0.30**	0.17	0.26
C7	**0.34**	**0.37**	**0.37**	**0.33**	**0.34**	**0.31**	0.17	**0.30**	**0.37**	0.28	**0.32**	**0.35**	**0.29**	**0.32**	**0.30**	**0.33**	0.25	0.23	**0.29**
C8	0.25	**0.32**	**0.30**	**0.31**	**0.33**	0.27	**0.31**	0.13	**0.31**	**0.30**	**0.30**	**0.31**	**0.30**	**0.31**	**0.29**	**0.30**	0.28	0.24	0.25
C9	**0.29**	**0.35**	**0.34**	**0.29**	**0.33**	0.28	**0.34**	**0.32**	0.15	0.28	**0.29**	0.26	0.24	**0.30**	0.28	**0.31**	0.23	0.18	0.24
C10	0.17	**0.30**	0.27	**0.30**	**0.30**	**0.31**	0.27	0.28	**0.30**	0.11	**0.31**	0.24	0.22	0.25	**0.27**	**0.28**	**0.29**	0.15	0.19
C11	0.23	**0.32**	0.27	**0.32**	**0.31**	**0.31**	**0.31**	**0.30**	**0.30**	0.28	0.14	0.24	0.27	**0.27**	**0.29**	**0.31**	**0.29**	0.23	0.26
C12	0.24	**0.36**	**0.34**	**0.32**	**0.36**	**0.32**	**0.36**	**0.32**	**0.32**	0.29	**0.31**	0.14	**0.30**	**0.32**	0.25	**0.30**	0.28	0.17	**0.28**
C13	0.26	**0.30**	0.27	0.27	**0.30**	0.22	**0.30**	0.28	**0.27**	0.23	0.27	**0.29**	0.11	**0.34**	0.18	0.19	0.24	0.23	0.23
C14	0.16	**0.33**	**0.33**	**0.30**	**0.30**	0.24	**0.28**	0.29	**0.31**	0.28	0.25	0.27	**0.32**	0.12	0.15	0.16	0.24	0.15	0.26
C15	**0.28**	**0.35**	**0.33**	**0.31**	**0.29**	**0.30**	**0.36**	**0.31**	**0.32**	**0.30**	**0.34**	**0.30**	0.26	0.25	0.11	**0.32**	0.21	0.26	**0.28**
C16	**0.31**	**0.33**	**0.36**	**0.34**	**0.33**	**0.34**	**0.37**	**0.33**	**0.36**	**0.32**	**0.37**	**0.35**	**0.29**	**0.29**	**0.34**	0.14	0.25	0.26	**0.30**
C17	0.12	0.21	0.16	**0.29**	**0.31**	**0.29**	0.23	**0.28**	0.25	**0.29**	**0.28**	0.22	0.23	0.25	0.21	0.20	0.11	0.14	0.21
C18	0.24	0.23	**0.29**	0.20	0.21	0.18	0.23	0.25	0.23	0.24	**0.28**	0.18	0.21	0.24	0.21	0.21	0.18	0.10	**0.31**
C19	**0.29**	0.27	**0.28**	0.19	0.19	0.19	0.22	0.19	0.20	0.19	0.21	0.15	0.18	0.18	0.24	0.24	0.20	**0.28**	0.09

Note : Bold values are ≥ threshold value of 0.27

Table 6. Results of grey-DEMATEL analysis

Code	Factors	R	C	R-C	R+C	Group
C1	Availability of Funds and Financial Investment	4.66	4.45	0.22	9.11	**CAUSE**
C2	Clear implementation plan	5.46	5.78	-0.32	11.24	EFFECT
C3	Digital strategy	5.79	5.60	0.18	11.39	**CAUSE**
C4	Effective Communication	5.14	5.45	-0.31	10.60	EFFECT
C5	Employee engagement	5.03	5.67	-0.64	10.71	EFFECT
C6	Employee empowerment	5.14	5.01	0.14	10.15	**CAUSE**
C7	Goal Clarity	5.85	5.63	0.22	11.48	**CAUSE**
C8	Leadership	5.40	5.30	0.10	10.70	**CAUSE**
C9	Long-term Commitment to DP	5.32	5.62	-0.31	10.94	EFFECT
C10	Organization Culture	4.81	4.97	-0.16	9.78	EFFECT
C11	Perception of Readiness to Change	5.25	5.52	-0.27	10.77	EFFECT
C12	Performance measurement	5.58	5.11	0.47	10.69	**CAUSE**
C13	Skillful employee or digital expertise	4.77	4.90	-0.13	9.68	EFFECT
C14	Standardization the process of work	4.73	5.28	-0.56	10.01	EFFECT
C15	Top Management commitment and understanding	5.46	4.58	0.88	10.05	**CAUSE**
C16	Top management support	5.98	4.92	1.06	10.90	**CAUSE**
C17	Trust among Employee	4.25	4.46	-0.21	8.72	EFFECT
C18	Availability of existing infrastructure	4.22	3.83	0.39	8.05	**CAUSE**
C19	Cyber security strategies	3.98	4.74	-0.76	8.73	EFFECT

Based on the result from Grey DEMATEL, the digraph is to illustrate the relationship between factors as in Figure 1. The arrow from factor points to factor b means that factors a influence the matter for factors b.
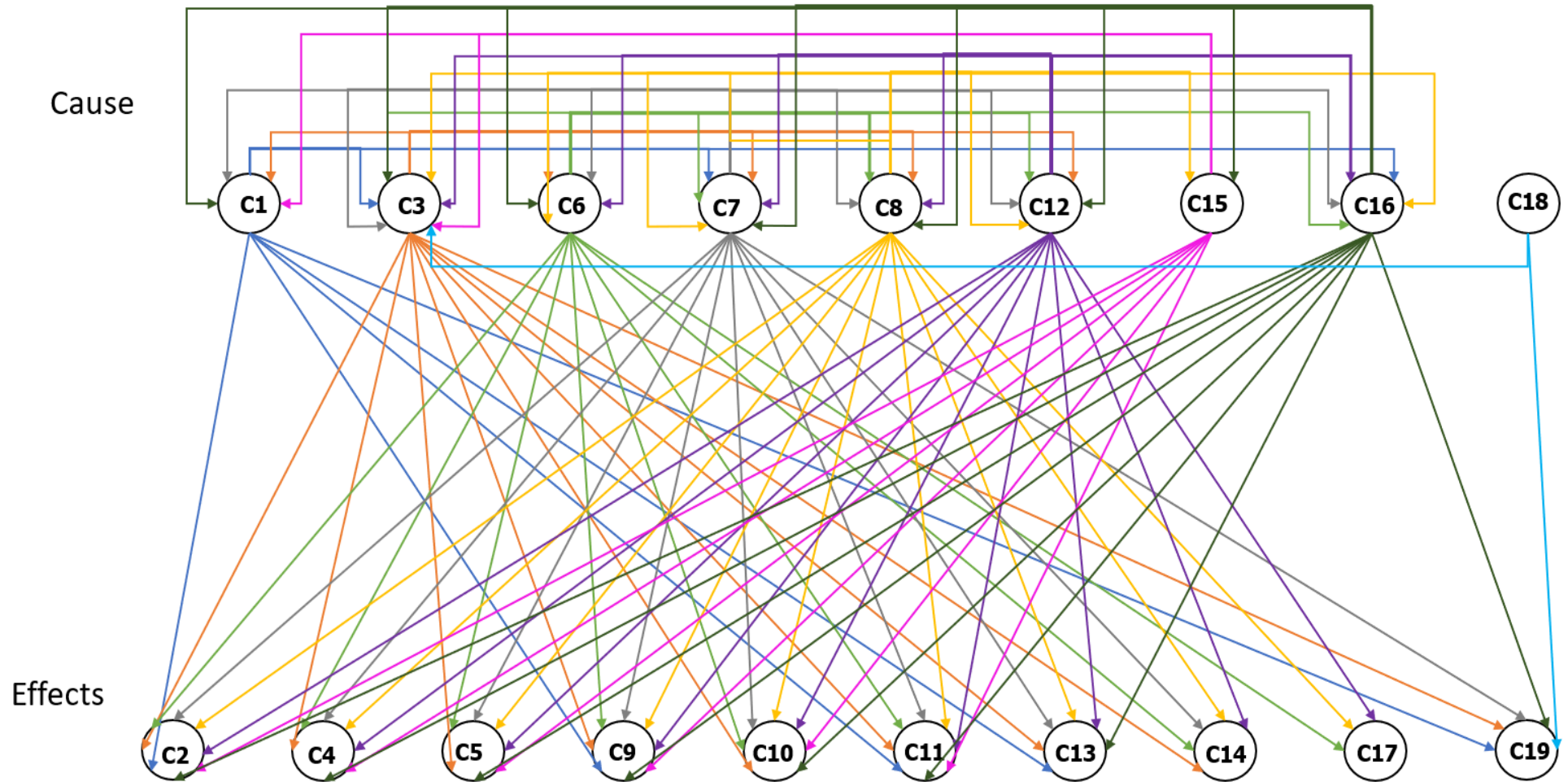

Figure 3. The influent network relationship map

5. Conclusion

The purpose of this study is to identify the factors that influence of success in DT for LSPs and establish the relationship among factors. The result from $r+c$, from table 8 shows the factors are determined from the highest value are identified as the most important factors due to the fact that results from $r+c$ show the intensity of influences. In this study there are Clear Implementation Plan, Digital Strategy, and Goal Clarity, therefore the priority is given to this group. Especially, Goal Clarity as it gets the highest value from $r+c$. The second factors that has high influence value is Digital strategy, in this study it was explain as the way that organization will use digital transformation with their operation or their new products/services for more value creation. From the most important factors that are identified, it implies to the management need to know exactly for what they expect from this transition and then they are obligated to set the most suitable plan for implementations. This means that the management need to focus on the top causal factors in order to create a promising plan for adopting digital transformation. Meanwhile, the effect factors should be monitor during the process as well.

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