A Design Science Enabled Organizational Capability State Measurement Approach

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ABSTRACT

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Organizational capability plays a critical role in creating and maintaining an organization's competitive advantage. It enables organizations to develop and implement organizational strategies and business models. However, the measurement of the organizational capability to assist the prediction of organizational performance remains a challenging task. It is especially challenging for organizations with limited resources, such as monetary resources, time and the expertise to organizational capability and instrument for measuring organizational capability. The challenge is two-fold. Firstly, organizational capability measurement aims to predict organizational performance rooted in individual performance. However, it is challenging to find a practical framework that links individual performance with organizational performance and guides the organizational capability measurement by considering the individual factors. Secondly, the questionnaire is widely used for measuring individual knowledge, attitudes, emotion and perceptions. However, questionnaire design methods are still very ill-defined processes that the generation of items heavily relies on the experience of experts or the questionnaires designed by other researchers about a similar topic. This research aims to provide an organizational capability state (OCS) model and develop a framework for questionnaire design using a design methodology — Environment Based Design (EBD). The primitive factors for OCS are organizational members' knowledge, skills and the perception of workload and affect. The

questionnaire design framework achieves the OCS measurement by developing a questionnaire for assessing organizational members' knowledge, skills, perception, affect and goal. With two case studies, the framework of questionnaire design is proved to be effective in questionnaire design. The combination of the OCS model and questionnaire design framework enables a cost-effective and less expert-dependent measurement of organizational capability.

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Chapter 1. Introduction

1.1. Problem statement

Organizational capability plays a critical role in creating and maintaining an organization's competitive advantage (Collis, 1994; Teece, 2014; Teece, 2018; Ulrich and Lake, 1991). Organizations with solid capability and resources will have the advantage in competition, which will help these organizations take the lion's share of the market and dominate the market. The resource-based view emphasizes gathering valuable, rare, imperfectly imitable, and non-substitutable resources to build and support a firm's competitive advantages (Barney, 1991). However, resources will not produce output unless capability enables organizations to allocate and organize resources with the appropriate strategy and business model (Teece, 2018). The design and implementation of a business model are dependent on the organizational capability, notwithstanding that the development of strategy is impossible without consideration of the business model (Teece, 2018). In other words, organizational capability enables organizations to develop and implement organizational strategies and business models.

However, the measurement of the organizational capability to assist the prediction of organizational performance remains a challenging task. It is especially challenging for organizations with limited resources, such as monetary resources, time and expertise to organizational capability and instrument for the measurement of organizational capability since the assessment of organizational capability usually requires both expertise of organizational capability and the measurement instrument that it is costly to hire experts acquiring both kinds of knowledge. The quickly changing business environment results in diverse and frequent demands on the organizational capability assessment. This further illustrates the importance of a practical method that can help an organization effectively measure its organizational capability specific to its environment and is less dependent on expertise to reduce the cost.

1.2. Research objective

This research aims to provide an organizational capability state (OCS) model and develop a framework for questionnaire design using a design methodology — Environment Based Design (EBD). OCS is a concept model for measuring organizational capability. The primitive factors for OCS are organizational members' knowledge, skills and the perception of workload and affect. The questionnaire design framework achieves the OCS measurement by developing questionnaire for assessing organizational members' knowledge, skills, perception, affect and goal. Every organization has its environment, so the generation of measurement instruments becomes a design problem, which is hardly possible to solve with the existing method. The use of EBD design methodology is to help designers adaptively design measurement instruments for the assessment of OCS in consideration of the environment of an organization. With the EBD, a designer can effectively gather new knowledge for the design problem without experience and assistance from experts.

1.3. Thesis organization

This thesis is organized as follows: chapter 2 critically reviews the literature and formulates the basis for proposing the research method and the model. Chapter 3 presents the theoretical basis of the OCS and the proposed method for developing OCS measurement tools. Chapter 4 demonstrates the EBD-enabled measurement tool development approach with an experimental case study for developing key performance indicators (KPI). Chapter 5 shows how the EBD-enabled measurement tool development approach assists the OCS measurement by constructing a new questionnaire specific to the research environment and target organization. Chapter 6 discusses the theoretical and practical implications of this research and outlines future work.

Chapter 2. Literature review

2.1. Organizational performance and individual performance

2.1.1. Individual performance

Individual performance is a concept that evokes researchers' interests from a wide range of research fields, such as management, education, sports, nursing, etc. The individual performance in this paper refers to a generic concept, which is usually termed as individual work performance or individual job performance (Dalal et al., 2020; Zeglat & Janbeik, 2019). According to the dictionary, the word performance is defined as "something accomplished" or "the execution of an action" that the former could be interpreted as the outcomes of behaviour while the latter refers to the behaviour itself (*Definition of PERFORMANCE*, 2021). Despite the interchangeable meanings used in the language in an everyday context, researchers widely endorse defining the job performance as a multi-dimensional concept describing the behaviours at work place rather than the outcomes of these behaviours (Campbell et al., 1990; Koopmans et al., 2011; Zeglat & Janbeik, 2019). In addition, this definition only applies to the behaviours that are relevant to the organization's goals (Campbell et al., 1990; Campbell & Wiernik, 2015). Moreover, job performance is not a synonym to efficiency or productivity because the latter concept refers to the ratio between input and output rather the behaviour for turning the input into the output (Campbell & Wiernik, 2015).

The definition of individual job performance has clearly illustrated that the individual behaviour in the working context is specific to organizations, especially the organization's goals. This relation implies that the exact indicators of dimensions of job performance vary from job to job; however, previous research has revealed that some dimensions are essential components of job performance across different contexts (Koopmans et al., 2011). Koopmans (2011) systematically reviewed studies on job performance across medical, psychological and management fields and summarized

four generic dimensions of job performance considered critical in most previous studies: task performance, contextual performance, adaptive performance counterproductive work behaviour. According to Campbell's review (2015), core technical performance, contextual performance, organizational citizenship behaviour, and counterproductivity behaviour are four dimensions that should be considered in different working contexts. Task performance or core technical performance are behaviours contributing to the generation of goods or services that are the organization's products (Campbell & Wiernik, 2015; Dalal et al., 2020). Contextual performance is defined as behaviours that serve and maintain the core technical functions by supporting the social and psychological environment (Campbell & Wiernik, 2015; Koopmans et al., 2011). In contrast, counterproductive behaviour is defined as voluntary behaviours that harm or are intended to harm the organization's well-being, which could result in undesirable consequences for the organization and its stakeholders (Dalal et al., 2020; Koopmans et al., 2011; Ones & Dilchert, 2013). Adaptive performance refers to the employees' behaviours to respond to changes in the work environment and roles (Dalal et al., 2020; Koopmans et al., 2011). Although organizational citizenship has been distinguished from contextual performance in some research (Campbell & Wiernik, 2015), it is recognized as a synonym to contextual performance in other researches (Koopmans et al., 2011; Organ et al., 2011). In addition, proactive behaviour (the behaviour employees engage to impact the work environment or themselves), creative behaviour (the behaviour that contributes to the generation of new ideas or new products), adaptive performance and other performance are also considered as critical dimensions of job performance (Campbell & Wiernik, 2015; Dalal et al., 2020; Koopmans et al., 2011). The definitions of job performance's major generic dimension only give a vague description of their meanings; however, previous studies have revealed that the indicators of these dimensions can be detected in job-specific environment. The four generic dimensions and the corresponding indicators are shown in Figure 1.

Construct	Dimension	Indicators

	Task performance	Completing job tasks, work quantity, work quality, job skills, job knowledge, keeping knowledge up-to-date, working accurately and neatly, planning and organizing, administration, decision-making, solving problems, oral and written communication, monitoring and controlling resources
Individual work performance	Contextual performance	Extra tasks, effort, initiative, enthusiasm, attention to duty, resourcefulness, industriousness, persistence, motivation, dedication, proactivity, creativity, cooperating with and helping others, politeness, effective communication, interpersonal relations, organizational commitment.
	Adaptive performance	Generating new, innovative ideas, adjusting goals and plans to situation, learning new tasks and technologies, being flexible and open-minded to others, understanding other groups or cultures, showing resilience, remaining clam, analyzing quickly, acting appropriately.
	Counterproductive work behavior	Off-task behavior, too many of longer breaks, presenteeism, absenteeism, complaining, tardiness, doing tasks incorrectly, accidents, insulting or gossiping about coworkers, fighting or privileges, aggression, theft, substance use.

Figure 1: Heuristic framework of individual work performance (Koopmans et al., 2011)

2.1.2. Relation between individual performance and organizational performance

Organizational performance is rooted in individual performance. Individual performance plays a vital role in the success of an organization, and successful companies and government organizations recognize it as a crucial contributor to the overall organizational performance (Almatrooshi et al., 2016; Jiang et al., 2012; Kim, 2004; Siengthai & Pila-Ngarm, 2016). Individual performance is a vital factor that mediates the influencing factors at the individual and collective performance at organizational levels (Zeglat & Janbeik, 2019). Kim (2004) states that Job satisfaction, affective commitment, public service motivation, and organizational citizenship behaviour plays a critical role in the performance of government organization by directly impacting individual performance. Kim (2004) concluded from the research results: "people are the important cause of good organizational performance."

Every individual could contribute to organizational performance by performing their tasks well. However, not every individual contributes evenly to the overall organizational performance, where the nature of a position determines the relation between individual performance and organizational success (Jacobs, 1981). The determinants include: (1) the interdependence between positions (pooled or sequential),

(2) chance of individual success (common or infrequent), (3) credit for an exemplary (common or rare), (4) the effects of individual performance to the overall organizational performance (profound or limited) (Jacobs, 1981). The nature of positions of individuals in an organization results in a non-linear relation between the organizational performance and specific individuals (Bonache & Noethen, 2014). This relation also explains why the leader's performance is considered more critical than the performance of an employee to the organizational performance. Even among leaders, jobs require different performance and contribute differently to the overall organizational performance. Task difficulties and task dependence are two particularly important characters that distinguish star-job and guardian-job (Bonache & Noethen, 2014). The star-job is a job with a relatively low chance to perform very well; however, a good performance results in exponential gain in organizational performance while a bad performance has limited impact on organizational performance (Bonache & Noethen, 2014). In contrast, the guardian-job is relatively easy to achieve average or slightly above the average performance, but a good performance has limited contribution to the organizational performance while a bad performance might become a catastrophe to the organizational performance (Bonache & Noethen, 2014). Thus, it is necessary to consider the relationship between individual performance and organizational performance when we try to improve organizational performance through managing individual performance in an organization.

2.2. Influencing factors of individual performance

2.2.1. Stress

It is a widely accepted idea that individual performance is dynamic. Meta-analysis research has analyzed the longitudinal between-person samples and concluded that the individual performance is more likely to be a dynamic construct than a stable one (Sturman et al., 2005). The performance variation between people could be explained by the difference in the individual cognitive capability, knowledge, skills, and physical

conditions. However, the dynamic of individual performance is not a unique phenomenon that only appears in between-person conditions. People's performance could vary with time and situation. A similar phenomenon is also observed in animals by Yerkes and Dodson, who conducted a series of experiments in their animal experiment in the early 20th century, testing the relationship between stimulus strength and the speed of mice in discriminating coloured boxes (Yerkes & Dodson, 1908), and the Yerkes-Dodson Law is a well-known theory, named after Yerkes and Dodson. The results showed that the relationship between the behaviour and stimulus strength varied with task difficulties, and the relationship was an inverted U-shape curve when performing difficult tasks. (Corbett, 2015; Hanoch & Vitouch, 2004). This relation is widely used to explain the effects of emotional stimuli on human performance and indicates that some stress is necessary for people to deliver good performance (Corbett, 2013, 2015; Hanoch & Vitouch, 2004). According to the law, human performance is relatively low when staying in the comfort zone with little stress (Corbett, 2013). The rising stress stimulates people and improves performance until the peak, after which further stress increases result in performance decreases. Peak performance state is where people can fully use human power and intelligence (Corbett, 2013). Studies on working memory showed that exposure to stress could enhance learning performance by influencing working memory (Lai et al., 2014). People with higher working memory do not consistently outperform those with lower working memory because task difficulty and stress mediates the relation between the working memory and performance (Beilock & DeCaro, 2007). The appropriate stimulus could induce people to reallocate attention to the goal-relevant task and mobilize their body for reacting to stimuli (Hanoch & Vitouch, 2004). It could enhance individual performance by creating a feeling of hope and a sense of meaning (Hargrove et al., 2013). However, over-stimuli may restrict the attention on too narrow cues and ignore some critical information that could cause the decrease of performance and the generation of anxiety (Hanoch & Vitouch, 2004; Lottridge et al., 2011; Podsakoff et al., 2007). Thus, appropriate

affective arousal is the precondition for promoting human performance (Hallett & Hoffman, 2014; Hanoch & Vitouch, 2004; Jeon et al., 2014).

Based on the Yerkes-Dodson law, Nguyen and Zeng (2012, 2017) developed a mental stress model regarding knowledge, skills, affect, and perceived workload as four primitive factors determining human mental stress (Equation 1). Knowledge, skills, and affect make up the mental capacity, where knowledge and skills together represent the rational part, while affect is the irrational part. The perceived workload is the perception resulting from the subjective interpretation of objective workload. It is produced by the interaction between humans and the environment that humans analyze the environment and the objective workload using their knowledge and skills to generate the perceived workload. This process is not always rational since human affect could influence how knowledge and skills are utilized. As human capability comprises knowledge and skills, the relationships revealed by the mental stress model indicate that affect and perception influence human performance by changing the state of human capability. The four primitive factors interact with each other and result in mental stress, whose level dynamically corresponds to human performance resulting in an inverted U-shape curve shown in Figure 2.

$$Mental\ stress = \frac{Perceived\ workload}{Mental\ capacity} \qquad \text{Equation 1}$$

$$Mental\ capacity = (Knowledge + Skills) * Affect$$

Formula 1: Mental stress and mental capacity

Where the operation "+" indicates that the rational part of the mental capacity is made of knowledge and skill, while the operation "*" shows the irrational influence from emotion and attitude (Wang & Zeng, 2017).
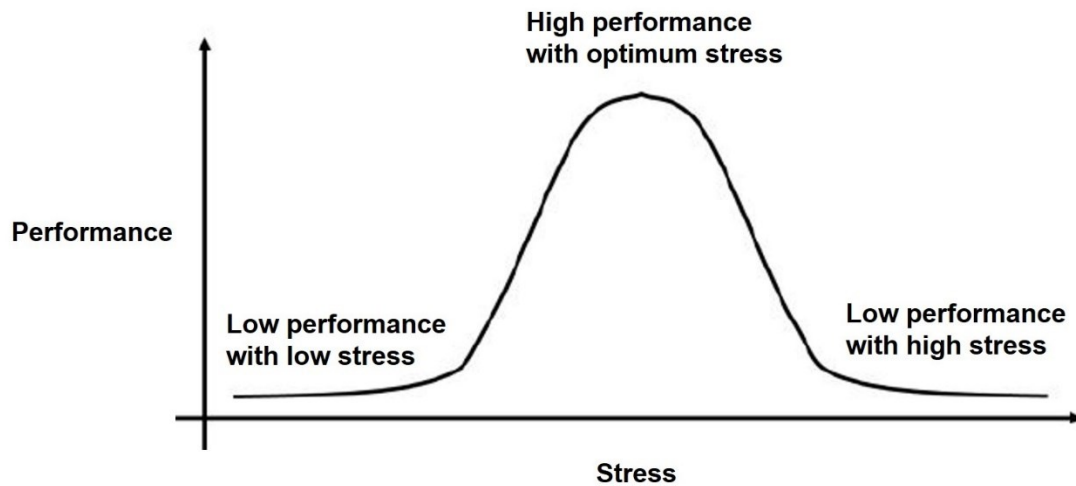
Figure 2: Relation between mental stress and performance

Studies on job performance support the relationship between mental stress and individual performance. Work stress is people's reactions to the person-environment conflict caused by the imbalance between work demands and the employee's ability to perform them (Clipa, 2019). It is induced by job stressors and leads to psychological, physical, and behavioural reactions (Nixon et al., 2011). The perceived stress is high when people perceive little support and are not confident in their ability and power of control to perform the demand in work (Rennesund & Saksvik, 2010). Individual performance is subjective to their responses aroused by different types of stressors. When a challenge stressor is perceived, the individual responds with behaviour potentially promoting their performance and achievements and creating a sense of meaning, hope, or vigour (Hallett & Hoffman, 2014). In contrast, a hindrance stressor could induce individual behaviour, which negatively impacts individual performance and constrain individual achievements (Hallett & Hoffman, 2014). Previous research has demonstrated that raising stress may harm job performance. In a longitudinal study conducted in Brazil, workers have lower cognitive performance when they report a higher level of stress (de Souza-Talarico et al., 2020). The workplace stressors could derive from decision-processing (e.g. information overload, decision uncertainty, fear of mistakes), profit pressure (e.g. profit goals, competition), workload (e.g. long working hours, time pressure) and social pressure (e.g. luck of social support)

(Oberlechner & Nimgade, 2005). Work-stress could also lead to physical (e.g. headache, backache, sleep disturbance, eye strain, fatigue), behavioural (e.g. isolation, alcohol dependency, aggressive behaviour, serious accidents), emotional (e.g. irritability, anxiety, worry, frustration) and cognitive (e.g. memory problems, concentration problems, difficulties to make decisions) symptoms. (Albertsen et al., 2010; Colligan & Higgins, 2006; Elfering et al., 2017; Gershon et al., 2009; Nixon et al., 2011). These symptoms could result in employee tardiness, low productivity and high absenteeism and turnover rate, which negatively impact the individual job performance (Foy et al., 2019). Although these results comply with the common understanding of how stressor contributes to the reduction of productivity, they only show part of the truth. A study on financial traders shows that high-performance traders report lower stress while high stress does not lead to lower trading performance (Oberlechner & Nimgade, 2005). Mughal (1996) revealed that higher stress evokes insurance sales consultants to exert greater work effort than their colleagues with low stress, resulting in better work performance. Topcic (2016) interviewed human resource managers working for organizations of public administration, public health, and education facilities and found that the high-performance work practices are both positively related to work performance and stress at work. This shows that individual job performance and stress could rise at the same time.

Despite the numerous studies on how stress impacts job performance, there is little result in this field reporting an invert U-shape curve linear relation. One important reason for the inconsistency between theory and empirical study results is the settings of studies in the real world. The studies on job performance usually rely on the case study in the real world rather than experiments in the lab, which leaves much space for the researchers to manipulate the setting of the studies, especially the level of stress and the difficulty of tasks. The majority of studies fall short of observing individual performance in under-stressed and over-stressed conditions in the same study (Muse et al., 2003). Due to the technical and ethical constraints, it is very challenging for

researchers to control stress levels at work place. Since the difficulty level of a task critically mediates how stress impacts individual performance (Teigen, 1994), lack of control of task difficulty may result in the incomplete stress-performance relation curve.

2.2.2. Knowledge and skills

According to Davenport and Prusak (1998), knowledge is defined as "a mixture of experiences, practices, traditions, values, contextual information, expert insight, and a sound intuition that provides an environment and framework for evaluating and incorporating new experiences and information." Tsoukas and Vladimirou (2001) defines knowledge as "individual capability to draw distinctions, within a domain of action, based on an appreciation of context or theory, or both." Despite the significant number of publications on this topic, there is not yet a consensus on the definition of knowledge (Moczydlowska, 2007). However, knowledge is usually divided into two sub-categories: knowledge and skills.

The definitions of knowledge and skills are similar but distinct. The knowledge is also called codified knowledge or explicit knowledge, which can be stored, coded, documented in semi-structured content such as books, documents, databases or other organized media using words or symbols (Harrington, 2018; Levallet & Chan, 2019; Sarwat & Abbas, 2020; van den Berg & Kaur, 2021). The acquisition of codified knowledge is achieved by teaching and learning through textbooks or visual media (Khan, 2019; van den Berg & Kaur, 2021). Skills are also called "know-how" or tacit knowledge (Harrington, 2018; Khan, 2019; Levallet & Chan, 2019; Sarwat & Abbas, 2020; van den Berg & Kaur, 2021). Skills are highly personal, practical and context-specific, and embedded in unconscious and complex routines (Khan, 2019; van den Berg & Kaur, 2021). They are deeply embedded in people's minds, and people's mental model is unique to an individual that everyone has a unique understanding of tacit knowledge (Sarwat & Abbas, 2020; van den Berg & Kaur, 2021). Due to the difficulty of formalizing tacit knowledge, the acquisition of tacit knowledge can only be achieved

through experience, in other words learning by doing (Khan, 2019; van den Berg & Kaur, 2021).

Codified knowledge and tacit knowledge are critical to performance and represent the primitive elements of the ability to accomplish goals in working place (Irawan et al., 2019; Pathirage et al., 2007; van den Berg & Kaur, 2021; Youndt & Snell, 2020). Henttonen and her colleagues (Henttonen et al., 2016) have investigated how knowledge sharing impacts the individual performance of employees in a public sector organization and concluded that knowledge-sharing behaviour leads to improved individual job performance. A similar effect has been detected among hospital nurses that knowledge-sharing enhances the individual performance of nurses (Rafique & Mahmood, 2021). It is relatively intuitive to regard knowledge and skills as critical factors of individual performance, yet, the research on knowledge-sharing provides evidence for the power of knowledge. Through knowledge-sharing, organizational members can gain new knowledge and new ways of utilizing knowledge (skills) to demonstrate the power of knowledge.

2.2.3. Affect

Affect is a generic word describing several related but distinct terms such as emotions, feelings, and moods (Forgas, 1995; Hudlicka, 2003; Jeon et al., 2014). Although researchers use these terms interchangeably in depicting irrational mental activities, their meaning has slight differences in the affective experience duration (Jeon et al., 2014; Lottridge et al., 2011). Emotion indicates the affective experience of relatively short duration, whereas the moods may last from several hours to days. The long-term affective trend is temperament, which is relatively stable and may last for life (Lottridge et al., 2011). The affective state at a specific point of time results from the interaction between emotion at a point of time, the moods of a period, and people's temperament (Lottridge et al., 2011).

There are several different perspectives proposed in previous studies to

characterize affect. One perspective regards emotions construct with multiple aspects, including distinct neural substrates, facial expressions, and unique feeling states. People develop basic emotions based on these aspects (Diener et al., 2020; Song et al., 2019). From this point of view, emotions are discrete units that each kind of emotion could result in corresponding job attitudes or behaviours (Harmon-Jones et al., 2017). Another perspective, the dimensional model, treats emotions as continuous variables provoked by underlying discrete emotions. From this perspective of view, an emotional state is characterized by two dimensions: valence dimension (positive or negative emotions) and arousal dimension (high arousal or low arousal) (Diener et al., 2020). The dimensional model emphasizes the valence and strength of emotional arousal as a mediator between discrete emotions and performance (Harmon-Jones et al., 2017). In other words, the effect of the emotional state is a result of its valence of emotion and the extent of emotional arousal rather than specific kind of emotions. Above mentioned two perspectives of emotions have a consensus on the function of an emotional state to the individual performance at work is determined by the valence or type of the emotion; it means that the positive emotional state has a positive implication on individual performance while the negative emotional state usually impairs the individual performance (Diener et al., 2020). However, a number of studies demonstrate that negative emotions do not necessarily lead to bad job performance (Gruber et al., 2020; Knight & Eisenkraft, 2015; Lindebaum & Jordan, 2014). This evokes an evolutionary perspective of emotions in organizational science to consider the function of emotions in their environment (Diener et al., 2020). Under this evolutionary perspective, the positivity of the emotion should not be characterized by feeling itself; instead, it should be evaluated by the outcome induced by the emotion (Lindebaum & Jordan, 2014). According to this new perspective, emotions should be assigned with positive or negative labels before the we realize how much the outcomes of the emotional arousal positively contribute to or impair the individual performance in achieving the organizational goal (Gruber et al., 2011). This could lead to a new understanding of

emotion similar to the stress-performance relation: positive emotions do not necessarily lead to good performance; an appropriate arousal is a key to achieving good performance.

Affect is closely associated with individual performance and job attitudes at work (Diener et al., 2020). Positive affect improves organizational citizen behaviour and restrains counterproductivity work behaviour, while negative affect is likely to provoke counterproductivity work behaviour (Dalal et al., 2009). Moreover, positive affect contributes to employee well-being, such as longevity, reduced incidents of stroke, higher sleep quality, lower intensity of illness and stronger immune resistance (Boehm & Kubzansky, 2012; Silton et al., 2020). In addition, emotion management ability is reported to be a good predictor of individual task performance (Kluemper et al., 2013). Emotions are also linked to creativity, work engagement, prosocial behaviour, teamwork and cooperation (Levine et al., 2018; Ouweneel et al., 2012; Radford, 2004; Roberts et al., 2014). The influential role of emotions in individual performance invokes the studies on the mechanic of emotional influence on individual performance.

The affect could directly influence individual performance (Hallett & Hoffman, 2014). The influential affective events theory (AET) proposed by Weiss and Cropanzano (1996) has established the pathway from environmental features, through work events and emotion, to behaviours. According to AET, the environmental features (job characteristics, pay levels, promotion opportunities, etc.) influence individual work attitudes, which serve as the baseline for individual judgment-driven behaviours. This pathway is driven by the individual perception formulated through the cognitive interpretation of working environment. Another pathway also starts from the environmental features which lead to different work events to arouse individual affective reactions as responses (Weiss & Cropanzano, 1996). The affective reactions directly produce the affect-driven behaviours and indirectly result in judgment-driven behaviours that influence work attitudes. The situation-attitude-behaviour pathway in AET proposes that the variation of between-person performance could derive from the

variance of person's interpretation of environment features in formulating the work attitudes. The final behaviour is driven by the judgment of the working environment (Dalal et al., 2020). In contrast, the events-affect-behaviour pathway in AET explains the variance of with-in-person performance that could result from the affective consequences and cognitive consequences of the fluctuant affective reactions triggered by the work events various over time (Dalal et al., 2020).

Several factors are identified as mediators of affect-performance relation. Atten is believed to be an important mediator of performance. Previous studies found three mediating mechanisms of attention in affect-performance relations: emotion regulation, rumination, and narrowing (Merlo et al., 2018). The negative affective states move attention away from a focal task through emotion regulation and rumination (Merlo et al., 2018; Ortner et al., 2013) and influence the individual responses by narrowing the information processing scope (Fredrickson & Branigan, 2005), though the negative affective states can improve memory and reduce judgement biases (Forgas, 2013). Conversely, positive emotion can promote performance by broadening the attentional scope and enhancing the attentional control to improve the task performance (Kuhl et al., 2015; Merlo et al., 2018). However, positive emotion can impair attentional control through emotion regulation and rumination in a specific work environment (Merlo et al., 2018; Moran et al., 2013). Another factor mediating the relation between affect and individual performance is the individual-level resources, including physical, intellectual, social, and psychological aspects, which are the cognitive, behavioural, affective and physiological outcomes of emotions (Diener et al., 2020). There are four routes for resources to mediate the performance: affect-to-cognition-to-outcome route, affect-to-behaviour-to-outcome route, affect-to-affect-to-outcome route, affect-to-physiology-to-outcome route (Diener et al., 2020). The affect-to-cognition-to-out route and affect-to-behaviour-to-outcome route follow the ATE that the affect could directly lead to behaviour or changes in perception, which are recognized as behavioural and cognitive resources, respectively. In contrast, the other two routes emphasize the

indirect pathway in influencing behavior. The affect-to-affect-to-outcome route shows the spirals effect in emotion generation process that positive emotions could enhance positive emotion (Diener et al., 2020). Then, the enhanced emotions lead to behaviors. The affect-to-physiology-to-outcome route take the physiological condition as a kind of resource to manage performance. This route is based on the view that emotions can indirectly enhance or impair individual performance by influencing health.

2.2.4. Perceived workload

Perception is a mental process through which people give meaning to events or the environment by interpreting their sensory impressions (Lattuch & Young, 2011; Maheshwari & Vohra, 2015). People observe events happening in the environment and subjectively generate the perception of those events. This process, in turn, influences people's behaviour responding to the environment (Dijksterhuis & Bargh, 2001; Ferguson & Bargh, 2004). That means people's behaviour is influenced by the interpretation of the environment rather than the objective reality that happens in the environment (Hallett & Hoffman, 2014; Maheshwari & Vohra, 2015).

The working environment differs from an organization to another, and the perception at the workplace becomes an issue covering a wide range of topics. Among the diverse perception of organization members, organizational commitment and self-efficacy are recognized as two critical ones that can influence individual performance. Organizational commitment is defined as an individual's relative strength in identifying and involvement in an organization (Kim, 2004; Radosavljevic et al., 2017; Watson & Papamarcos, 2002). High committed organizational members accept and believe in the organizational goal and values, and they are willing to work for the organization's success and maintain the membership in the organization (Kim, 2004; Watson & Papamarcos, 2002). This leads to higher job performance and higher organizational performance (Kim, 2004; Radosavljevic et al., 2017). Self-efficacy is defined as the individual belief in one's ability to use individual resources to achieve a goal (Bandura,

1997). Self-efficacy also promotes creativity and positive belief in one's efficiency and performance (Yaakobi & Weisberg, 2018). Sub-dimensions of self-efficacy include occupational efficacy, team-collective efficacy and means efficacy (Yaakobi & Weisberg, 2018). Occupational self-efficacy is the belief of individuals in successfully achieving a specific working goal. Collective efficacy reflects the individual belief in the group or the organization in where they are working. Means efficacy indicates the individual belief in the available tools and resources for their task. Individuals with strong self-efficacy are more willing to invest individual resources to perform a task and achieve better performance than those with lower self-efficacy (Yaakobi & Weisberg, 2018).

The perceived workload is a special kind of perception generated through people's interpretation of objective workload. It is influential on people's behaviour. When the workload exceeds the capacity, people may change their behaviour by quickly responding to catching up, lowering the work criteria, reallocating the attention from minor tasks to primary tasks (Hertzum & Holmegaard, 2013). This will impact individual performance and may lead more easily to burnout (Courtney et al., 2007).

2.3. Influencing factors of organizational performance

2.3.1. Organizational knowledge and skills

Organizational knowledge is a critical part of an organization's resources for the creation of added value (Sarwat & Abbas, 2020; van den Berg & Kaur, 2021). Studies have illustrated the impact of knowledge on financial, innovative performance and productivity (Bai & Yu, 2017; Mills & Smith, 2011; Ritala et al., 2015; Z. Wang & Wang, 2012; Zack et al., 2009). Organizations with a solid ability to use existing knowledge and create new knowledge are more likely to outperform their competitors (Dong et al., 2017).

Tsoukas and Vladimirou (2001) define organizational knowledge as "the capability members of an organization have developed to draw distinctions in the

process of carrying out their work, in particular concrete contexts, by enacting sets of generalizations (propositional statements) whose application depends on historically evolved collective understandings and experiences." According to this definition, it is evident that organizational knowledge is generated through the generalization and integration of individual knowledge. It is a collective knowledge shared by the organizational members.

Despite the collective nature of organizational knowledge, the creation of new knowledge, the sharing of existing knowledge, and the application of knowledge all occur at individual levels (Sarwat & Abbas, 2020; van den Berg & Kaur, 2021). It is the organizational members who create the new knowledge. In other words, the new knowledge is the consequence of the individual cognitive process (Sarwat & Abbas, 2020). An organization provides the environment for organizational members to implement the newly created knowledge (Grant, 1996). The creation of new knowledge at the organizational level is achieved through four processes: socialization, externalization, combination and internalization (Sarwat & Abbas, 2020). Socialization is an experience-sharing process through interaction between organizational members, promoting the diffusion of tacit knowledge from one organizational member to another (Moczydlowska, 2007; Sarwat & Abbas, 2020). Externalization promotes the generation of codified knowledge from tacit knowledge through writing thoughts, experiences and feelings into documents or reports (Moczydlowska, 2007; Sarwat & Abbas, 2020). The combination enables organizational members to learn transfer codified knowledge from written form to their mind by reading and learning to form new knowledge (Moczydlowska, 2007; Sarwat & Abbas, 2020). Internalization occurs when organizational members transfer codified knowledge to tacit knowledge through comprehending and practicing knowledge learned from written form (Moczydlowska, 2007; Sarwat & Abbas, 2020). Individuals' new knowledge diffuses through groups, organizations, and inter-organizational levels (van den Berg & Kaur, 2021). Knowledge diffusion is achieved through knowledge sharing between organizational members.

This enables the individual knowledge to be spread as organizational knowledge and be used to improve the efficiency and effectiveness of resource management of an organization (Henttonen et al., 2016). Individuals serve as the brain to store and spread organizational knowledge (van den Berg & Kaur, 2021). The role of an organization in creating organizational knowledge is to integrate individual knowledge, create new combination of individual knowledge, and consolidate the organizational knowledge through a combination of processes and capabilities (van den Berg & Kaur, 2021).

Organizational capability is a kind of task-oriented knowledge held collectively and transmitted by the organizational members (Garicano & Wu, 2012; Khan, 2019). It is the product of a process that integrates different kinds of individual specialist knowledge and skills owned and created by an organization (Grant, 1996; Tsai et al., 2012). The extent of integration determines the strength and type of organizational capability (Kusunoki et al., 1998).

2.3.2. Organizational climate: emotion and perception at the organizational level

The organizational climate is the organizational members' shared perception shaped by the events, policies, and procedures of an organization and the organizational rewards, support, and expectation on organizational members' behaviour (Schneider et al., 2013). It is an abstraction of the working environment based on organizational members' collective feelings and attitudes (Punwatkar & Verghese 2018; Schulte et al. 2009). The term climate is a multiple-level structure in social science that the psychological climate describes the perception of individual experience in the working environment. In contrast, the organizational climate represents the organizational members' shared understanding of the environment (Kessler 2019; Schulte et al. 2009). These two climates interact with each other in such a way that organizational climate is merged from psychological climates through the daily interaction of organizational members and influence the psychological climate by helping individuals understand what behaviour is expected and rewarded in an organization (Zohar & Luria, 2005).

Thus, organizational climate is based on and beyond the individual psychological climate (Schulte et al., 2009).

Organizational climate research has covered a broad spectrum of topics such as service climate, safety climate, innovative climate, ethical climate, the climate of diversity and so forth (Schneider et al., 2013). Service climate research on supermarkets, bank branches, and insurance companies have revealed a positive correlation between organizational service climate, customer satisfaction, and the organizational financial performance that high organizational service climate promotes the customer satisfaction rate and results in the growth of organization financial performance (Schneider et al., 2009). Research on ethical climate and fairness showed that organizational climate could influence employee's affect and job satisfaction (Bhaesajsanguan, 2010; Castro & Martins, 2010; Koles & Kondath, 2015). Researchers have investigated how the safety climate influences safety practice, job satisfaction, and employee engagement in safety climate fields. The results conclude that the elevation of safety climate moderated by the contextual factor can predictively decrease the accident rates in an organization, and an increasing safety climate promotes employee's job satisfaction and engagement (Huang et al., 2016; Schneider et al., 2013; Zohar & Luria, 2005). The positive relation between organizational climate and organizational performance may be due to the fact that an organization with a high positive climate is more effective in setting practical goals, enhancing project investment, and promoting organizational performance (Zwikael & Meredith, 2019).

2.3.3. Organizational goal setting

Goal setting is critical for both individual and organizational performance management. Individuals with a clear understanding of what they are expected to perform are more likely to be motivated and have a higher chance of achieving the goals (Ayers, 2015). Setting a practical goal could improve project decision-making, strategic management, and organizational performance and increase the chance of success

(Doherty et al., 2012; Serra & Kunc, 2015; Young & Poon, 2013).

Appropriately choosing the goal strategy is a task that should consider the difficulty of the organizational goal. Specific and attainable goals result in enhanced performance (Ayers, 2015; Zeglat & Janbeik, 2019). Outcome goals could enhance performance by increasing people's long-term motivation (Zwikael et al., 2018). However, setting process goals for challenging tasks are more beneficial for enhancing the performance since process goals could reduce uncertainty and help organizational members focus on the concrete steps to achieve the goal (Hallett & Hoffman, 2014). In a case where a clear process goal is not available for every organizational member, a realistic, achievable, measurable, flexible, and concrete outcome goal is more suitable than an abstract one for promoting employees' performance (Hallett & Hoffman, 2014; Zwikael & Meredith, 2019).

The goals of organizational members vary with the nature of their job and their position in the organization. Aligning the individual goal and organizational goal is necessary for coordinating the individual effort to achieve the organizational goal and contribute to the success of the whole organization (Ayers, 2015). The definition of goal alignment links individual outcomes with organizational outcomes (Ayers, 2015). This can be achieved through the organizational process, communication, structure, leadership, and management (Ayers, 2015). Researches have shown that the linking between individual goal and organizational goal could enhance both individual performance and organizational performance, improve the efficiency of an organization and lead the employees to become more productive and committed to their work (Ayers, 2015; Cainarca et al., 2019; Zeglat & Janbeik, 2019). With a good understanding of their roles in achieving organizational success, organizational members are more willing to invest their personal resources and give their knowledge, skills and abilities to improve individual performance and become team players to influence the performance of their colleagues, team, department and the whole organization (Alagaraja & Shuck, 2015).

2.4. Organizational capability

Organizational capability has been intensively researched and discussed for decades. Scholars have proposed various answers for this question, and they have reached a consensus that organizational capability is critical to build the competitive advantage and drive the performance of an organization (Collis, 1994; Teece, 2018; Teece, 2014; Ulrich and Lake, 1991). Organizational capability defines the way resources and people are organized together to deliver appropriate products and services to customers and represents the identity and perception of organizations (Smallwood & Ulrich, 2004). The solid organizational capability enables organizations to turn the technical know-how into products and services and promote the improvement of technology and business volume (Garengo & Bernardi, 2007; Smallwood & Ulrich, 2004). It also ensures the uniqueness of organizations, as the copy of organizational capability is much more difficult than the copy of technology and other market resources (Smallwood & Ulrich, 2004). The lack of organizational capability will leave organizations in crisis (Garengo & Bernardi, 2007) and lose the market position. All in all, organizational capability is the primary building block of competitive advantages and influences all aspects of organizations in a modern turbulent environment (Garengo and Bernardi, 2007; Teece, 2018).

Many definitions of organizational capability have been proposed over the last few decades. Dosiet al. (2008) and Eisenhardt and Martin (2000) defined organizational capability as organizational routines and managerial rules. According to Teece (2014), organizational capability is a set of enterprise activities using enterprise resources to deliver products or services. These definitions mainly take the resource-based view of firms. In contrast, the knowledge-based view defines knowledge as the ultimate source of organizational capability (Degravel, 2011). Organizations can hierarchically integrate various kinds of knowledge to generate different forms of organizational capability (Grant, 1996; Kusunoki et al., 1998). Moustaghfir (2009) argued that organizational capability is a combination of all knowledge assets whose applications

are influenced by the organization's cognitive processes. The most recent research (Khan, 2019) defines organizational capability as the knowledge that enables efficient collective activity. Indeed, both the resource-based and knowledge-based views are related in that an organization's knowledge assets are converted and integrated by organizational learning and knowledge management into socio-technical processes and organizational routines, which are the foundation of the organizational capability from the resource-based view (Moustaghfir, 2009). An organization comprises people with shared cognitive constructs or mental models and shared purpose (Robinson, 2020). Its members would take the initiative to make decisions and allocate resources using their knowledge and skills (Degravel, 2011; Ulrich, 1997; Ulrich & Lake, 1991). Thus, the knowledge and skills accessed by the organizational members collectively define the organizational capability of an organization.

2.5. Questionnaire design

The questionnaire serves as a vital instrument for data collection in various fields, including clinical assessment, political polls, marketing research, education evaluation and so forth (Geuens & De Pelsmacker, 2017; Lavrakas, 2008). Although the format and question sets vary with the scenario in different fields, a questionnaire, in general, is a set of standardized questions, which is systematically conceptualized and designed to collect individual data about predefined specific topics. Through the standardization of the questions, the data collected across individuals can be compared to one another (Lavrakas, 2008).

Questionnaires are widely used tools in social sciences. However, questionnaire design methods are still very ill-defined processes that are more of an art than a science (Ambrose & Anstey, 2010). A common weakness has been detected in most articles: the generation of items heavily relies on the experience of experts or the questionnaires designed by other researchers about a similar topic. Some textbooks and articles suggest using questions deriving from other questionnaires in similar fields and merging existing questions into a new questionnaire (Bradburn et al., 2004; Czaja & Blair, 2005;

Rattray & Jones, 2007). That means the construction of a questionnaire requires domain knowledge about the specific field and the knowledge of the questionnaire design (Bradburn et al., 2004; Czaja & Blair, 2005; Rattray et al., 2004; Rattray & Jones, 2007). These requirements have limited the construction of a questionnaire to specific groups and individuals who has access to both kinds of knowledge. On the one hand, the questionnaire design relies on survey experts' expertise; on the other hand, domain knowledge defines questionnaire design range and quality. However, in a context where previous questionnaires do not fit the current research environment, the validation and revision of existing questions require even more expertise than designing a new questionnaire. This requires a questionnaire design method to enable the design of a new questionnaire that is adaptive to the research environment. To the best of the author's knowledge, there is still no such method presented in the literature that can guide the questionnaire design from the initial ambiguous problem state to a questionnaire that can be deployed in a study.

Chapter 3. Proposed model and research method

3.1. Organizational capability state model

Although researchers have revealed the critical role of organizational capability, it is still challenging to find a practical framework to measure it. Some studies have introduced frameworks for organizational capability measurement; however, those studies have limited their scopes in a specific field (Evans et al., 2017; Jerez-Gómez et al., 2005; Kivipõld & Vadi, 2010; Tohidi & Jabbari, 2012). A method for managing organizational capability appliable in changing environment is yet to be designed. Thus, it is crucial to develop an organizational capability measurement framework that can be applied across different research fields.

Organizational capability is rooted in individual capability (Wang & Zeng, 2017), and that individual capability represents a critical aspect of organizational capability (Ulrich, 1987). Thus, this research introduces an organizational capability state (OCS) model for measuring organizational capability. It is derived from the stress performance model, which illustrates the four factors influencing individual performance. However, the four primitive factors are insufficient to determine the OCS since the task is not simply defined by individuals but assigned according to the organizational goal. In other words, the organizational goal is structurally decomposed and assigned to organizational members as tasks. Thus, the perceived workload is subjective to organizational goals in an organizational context. The organizational goal is equally as important as knowledge, skills, affect, and perception in defining OCS that the five factors together make up the primitive parameters of OCS. In contrast to the individual capability state, knowledge, skills, affect, and perception are applied differently in OCS. Organizational knowledge and skills are integrated by organizational members using their individual knowledge and skills. It is shared by organizational members through communication, activity and training. On the other hand, individual affect and perception collectively merge to organizational climate, representing the affect and

perception shared by organizational members.

A good OCS is indicated by clear and practical organizational goals, alignment between organizational goals and organizational members' individual goals at all levels, sufficient knowledge and skills shared by organizational members, positive organizational emotional and perceptual climate towards the individual tasks and organizational goal. Therefore, the assessment of OCS is achieved by measuring the knowledge, skills, emotional state, and perceptual state of individuals and assessing organizational members' collective state on knowledge, skills, emotion, perception, and goal setting. The OCS model is shown in Figure 3
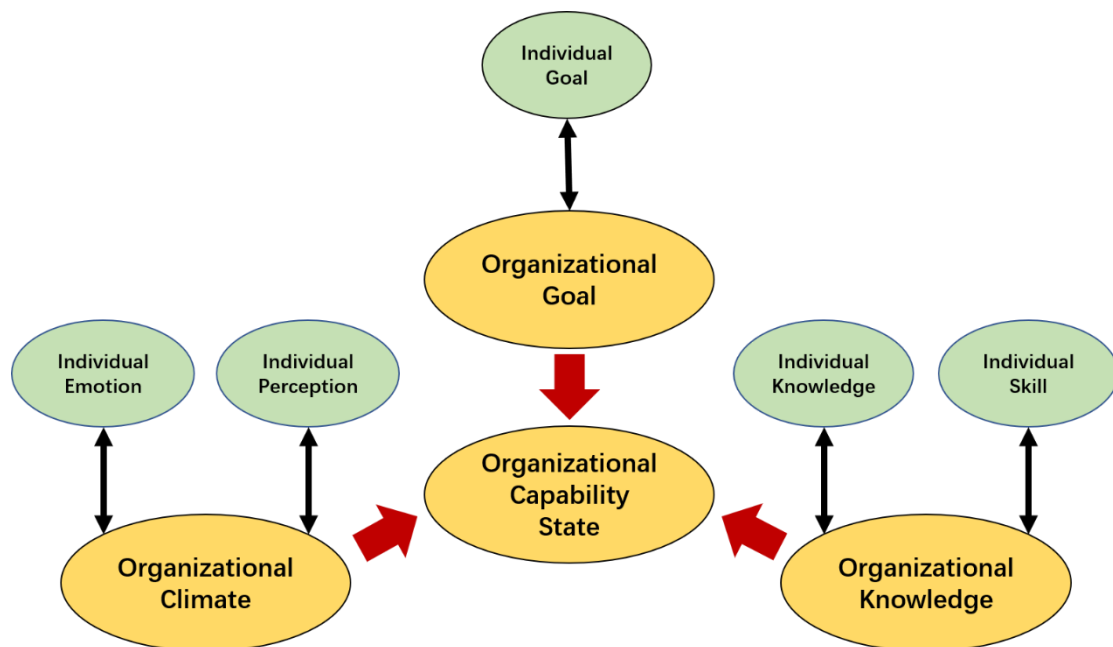
Figure 3: OCS model

3.2. Questionnaire design approach for OCS measurement

3.2.1. Questionnaire design is a design problem

The development of a questionnaire for assessment of OCS in a turbulent environment is a design problem because the research requirement changes over time and is implicit. Therefore, we use the EBD to develop a questionnaire design framework to measure the OCS accurately and adaptively.

A design problem is a wicked problem. A most vital character of a design problem is that it is ill-defined and ill-structured. Herbert A. Simon explained the characteristics of an ill-structured problem. According to his statement, there is no definite criterion to test a proposed solution for a wicked problem, and the problem space is not defined in any meaningful way (Simon, 1973). In the real world, there is no problem that is well-defined in the absolute sense. However, the degree of ill-structure of a problem defines whether a problem can be or should be regarded as a design problem (Simon, 1973). Rittel and Webber analyzed wicked governmental planning problems and has summarized ten distinct properties of a wicked problem (Rittel & Webber, 1973). According to these properties of a wicked problem, it is not hard to find that the questionnaire design is a wicked problem that eight out of ten properties of a wicked problem can be used to describe the context of questionnaire design.

To solve a wicked (ill-defined) design problem, designers cannot simply refer to their experience but have to design the solution (Mingers & Rosenhead, 2004). The logic of design is not inductive, deductive, and abductive that those logics play a dominating role in scientific research, but recursive. The recursive interactions between designers, design products, and design knowledge make design a process with a deep-loop characteristic. Rittel describes it as: "*you cannot understand the problem without having a concept of the solution in mind; and you cannot gather information meaningfully unless you have understood the problem, but you cannot understand the problem without information about it*." Design methodology aims to help designers jump out of the loop (Zeng & Cheng, 1991).

Various design methodologies have been developed to offer the designer a roadmap to follow in a design task. Nonetheless, as far as we know, no single design methodology fits for guiding design tasks in all different contexts. The functions and characteristics define the performance of a design methodology in a specific design context.

Sébastien Dubois etc., compared the usefulness of different design methodologies

by employing three of them — Algorithm of Inventive Problem Solving (ARIZ), Axiomatic Design (AD), or Environment-Based Design (EBD), in conducting various design tasks. ARIZ is a family of design methods that originated from the theory of inventive problem solving developed by Altshuller between 1956 and 1985. It was used to depict the design problem at the early stage of design. Suh develops AD to provide designers with a theory for decision-making in design. EBD is a design method derived from the logic of design — the recursive evolution. The goal of its developer Zeng is to provide a stepwise procedure to guide designers coping with the changing environment during a design process. The spirit of EBD is that design comes from the environment, serves the environment, and goes back to the environment (Sébastien et al., 2012).

The result of the research delivered direct evidence of the usefulness of each method. ARIZ is an excellent method to serve in the context of solving problems in existing systems or redesigning systems. It is also able to generate detailed solutions. However, the advantage of ARIZ has limited its capability of formulating the requirements of a design problem because it is too specific to fulfill this task. AD aimed at defining the functional requirements. The properties of AD make it an effective method in guiding hierarchically organized design teams to conduct large design projects with clearly identified requirements. However, the result showed that AD failed to depict explicit requirements of the design task. In contrast, EBD showed a result of an exhaustive analysis of the environment of the design task and was most effective in explicating the design requirements. Apart from that, EBD is also domain-independent and can be employed in solving different fields. Moreover, EBD is effective for open-ended problems to guide designers to search for essential domain knowledge. The only weakness of EBD is that it does not provide a detailed route for generating inventive solutions (Sébastien et al., 2012).

From the previous search result, we can find that EBD fits better than the other two design methods in guiding designers in explicating the complex and real

requirements of a questionnaire design task and searching for essential information for a new questionnaire. As the questionnaire already has a relatively well-developed procedure to refine the initial version of questions, the weakness of EBD does not negatively influence the whole questionnaire design process. In other words, the task of EBD is to build a framework for the questionnaire design to make this process more rational and smooth.

3.2.2. Environment Based Design: a method for solving the design problem

Environment Based Design (EBD) is a design methodology focusing on "Environment." The environment represents the world where the design product works. It consists of all the objects with direct and indirect relations with the design product (Zeng, 2002). EBD is based on the observation that design starts from the environment, functions in the environment, and returns to the environment (Zeng, 2015). EBD supports design by three activities shown in Figure 1: 1) from the problem statement, analyzing the product's known environment and establishing the environment structure with the components and their relations, including all working environments identifiable from the product lifecycle analysis. The outcome will take the form of a performance network, which shows how expected product actions will interact with each other; 2) identifying the conflicts and critical performance from the performance network; 3) in resolving the conflicts, generating the solution with the support of corresponding knowledge; otherwise, decomposing the environment components until the environment relation can match with available knowledge or by discovering new knowledge. Each solution will make a part of the environment for the proceeding design; thus, it updates the existing environment. The solution serves as the starting state of the next iteration. These activities, named after environment analysis, conflict identification, and solution generation, recursively produce the unknown product structure from the known environment until the end of the design. The design problem, the design knowledge, and the design solution evolve simultaneously to the final state

where there is no undesired conflict (Zeng, 2020, 2012).

Figure 4: Process of EBD design methodology

Environment analysis aims to comprehensively explore the necessary environmental structure, which is a performance network connecting environment components through expected product actions. The purpose is realized with EBD tools, such as the ROM diagram, question generation, and answering templates, which are shown in Table 1, 2 and 3, respectively (Zeng, 2008, 2020). For designers, the tools help achieve the question-driven environment analysis. For the details of tools, please refer to (Zeng, 2008, 2020). We will only introduce the underpinning thinking here.

Conflict identification aims to identify the conflicts from the performance network formed by the environment components and their relations. A conflict arises when a root action cannot occur due to insufficient resources or when an existing action will trigger other actions contradicting with existing ones. Each conflict represents a sub-design problem seeking an immediate solution.

Solution generation is an iterative process of atomic design and object resolution (Zeng & Cheng, 1991). The solution is only obtained in the atomic design in which designers have sufficient knowledge to resolve a conflict. If there is no sufficient knowledge in resolving the conflict, designers will need to either explore the existing knowledge or decompose the environment components and interactions via a new round of environment analysis until existing can be found or new knowledge can be discovered

Table 1: Rules and graphic representation of ROM adapt from Zeng (2011)
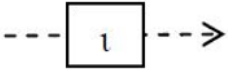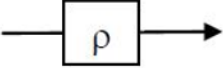
	Type	Graphic	Definition
Object	Object Compound object	O	Everything in the universe is an object. A compound object is an object that includes at least two other objects in it.
Relations	Constraint	●————→	It is a descriptive, limiting, or particularizing relation of one object to another.
	Connection	- - -⊡ ι ⊡- -≫	It is to connect two objects that do not constrain each other.
	Predicate	——⊡ ρ ⊡——→	It describes an act of an object on another or that describes the states of an object.

Table 2: Rules for question generation based on ROM adapt from Zeng (2011)

Rule 1	Before an object can be further defined, the objects constraining them should be refined.
Rule 2	An object with the most undefined constraints should be considered first.
Rule 3	If an object has the most number of constraints and/or predicates on other objects, it should be considered first.

Table 3: Question generation templates adapt from Zeng (2011)

Number	Conditions	Question template
T1	For a concrete, proper, or abstract noun object N without any constraint	What/Who is N?
T2	For a concrete, proper, or abstract noun N with an adjective constraint A	What is A N?
T3	For a noun object A constraining a noun object N	What is A? What is/are A N?
T4	For a verb V with its subject N1 and object N2	What do you mean by V in the statement "N1 V N2"? How do/does N1 V N2? Why do/does N1 V N2? When do/does N1 V N2? Where do/does N1 V N2?
T5	For a verb object, V is constrained by an adverb A with its subject N1 and object N2	What do you mean by V A? Why do/does N1 V A N2? When do/does N1 V A N2? Where do/does N1 V A N2?
T6	For a verb V with an object N but missing its subject	What/Who V N?
T7	Domain-specific object N or A N	What is the lifecycle of N or A N?

Design knowledge, here defined as the knowledge bridging the design problem to the design solution, is collected, integrated, and synthesized step by step in the design process, not based on experience but on domain-independent method. The EBD activities present a path for design knowledge being explored and exploited in referring

to academic publications via answering questions and consulting the necessary domain expertise. EBD plays a role of an organizer, a coordinator, or a mobilizer to integrate available knowledge or to discover knowledge in a question-driven manner.

3.2.3. The proposed approach for the measurement of OCS

The framework illustrated in Figure 5 is a question-driven process that starts with analyzing the environment using the EBD methodology. Environment analysis aims to describe the real and complete research requirement since the task statement is usually general, implicit, and specific to the environment. This process is achieved using EBD tools whereby information is gathered through a question and answer technique guided by EBD. Literature review and interviews are common methods that can provide reliable information for environment analysis. The product of environment analysis is a set of information to explicate the requirement of research task. It is also the input for the next step, whereby a list key components is generated from the critical parameters. This list is the guideline for the solution generation to design a survey questionnaire adaptive to the research task. This questionnaire could be applied in the data collection process to produce OCS raw data, which will be analyzed in the OCS assessment process using qualitative and quantitative analysis methods to understand OCS comprehensively. The output of the OCS assessment is an OCS report about the merits and weaknesses of an organization's capability. A general conclusion on the OCS is also presented in the report. The OCS report informs the target organization about its OCS and provides a comprehensive insight into potential opportunities for improving the OCS. Feedback is also essential for the assessment as the organizational members may have some experience that can approve the effectiveness of the assessment. For longitudinal studies, feedback can provide new research goals and requirements. The research team could also cooperate with the organization to generate a plan for the OCS improvement. Implementing the plan requires a new round of OCS measurements to assess the effectiveness of OCS improvement until the OCS can achieve the

organizational goal. This recursive process enables the continuous improvement of OCS and allows the organization to control its OCS in a dynamic environment.
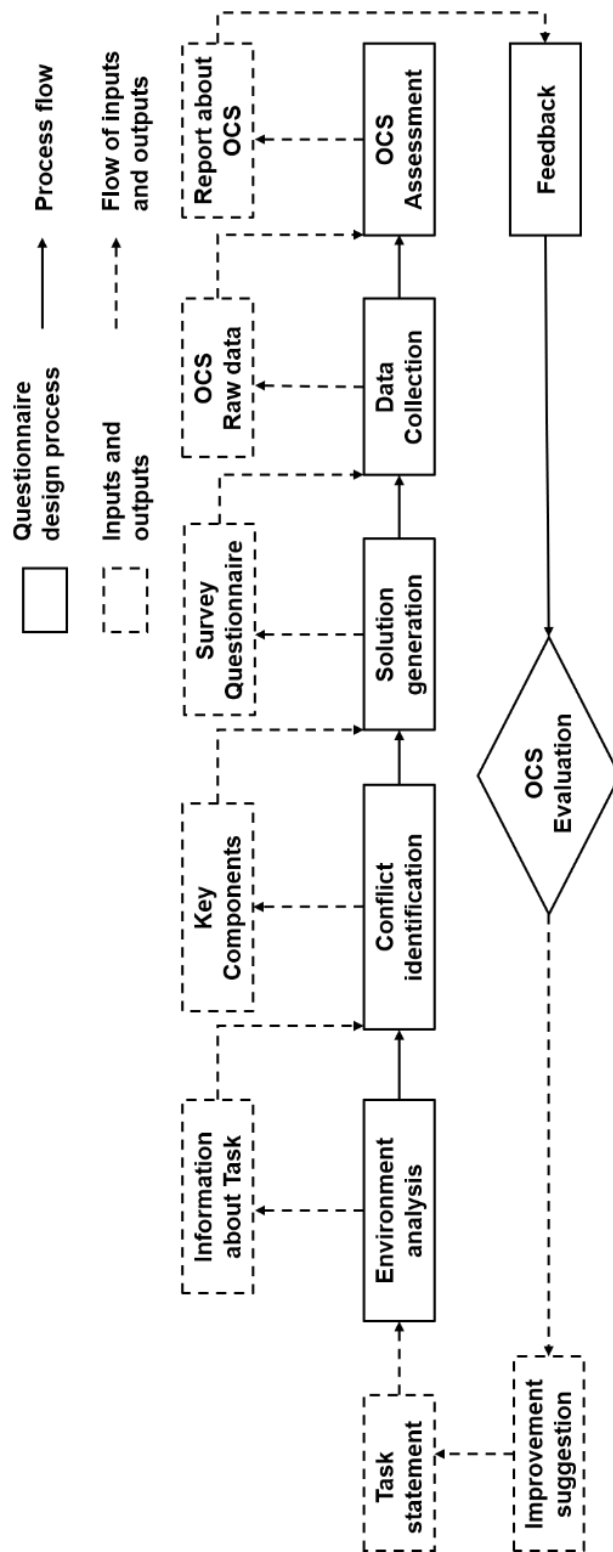
Figure 5. Organizational capability state measurement process

Chapter 4. Applying EBD in Key Performance Indicator Development

The approach of questionnaire design is similar to the development of KPI in finding the key performance that could critically influence an organization's performance. Therefore, a case study on KPI development is conducted to develop a questionnaire design method enabled by a generic design method EBD. However, there are two ways to conduct the EBD approach. Therefore, an experiment has been conducted to determine which approach is more effective.

The proposed EBD-enabled KPI development approach is achieved by adopting the EBD methodology in the KPI development process. The conceptual structure of the KPI development process and its corresponding stages in EBD methodology are shown in Figure 6. An organization's mission strategically defines what the organization wants to be, which serves as the initial input of the proposed KPI approach. In the extreme scenario, before generating KPIs, the concerned organization might only have its mission statement for its strategic development to analyze its goals. Alternatively, the approach can also start with a few goals implementing the mission statement. The organization will be modelled in actions using the EBD-enabled KPI development approach, in which the actions to achieve the goals are identified in the environment analysis. The goals will be decomposed into actions. Multiple actions may contribute to a single goal or several goals, while some are more effective, efficient, and thus more critical. The key performance indicators will be developed based on the key performances derived from performance networks to guide people's behaviour in an organization. The three steps of EBD — environment analysis, conflict identification, and solution generation are responsible for decomposing missions to actions, identifying key performance, and generating KPIs, respectively. The environment analysis is the most time-consuming step followed by conflict identification since EBD methodology focuses on gathering the information from the environment instead of the direct generation of the solution. This approach could help the designers overcome the

fixation and generate solutions adaptive to the environment.
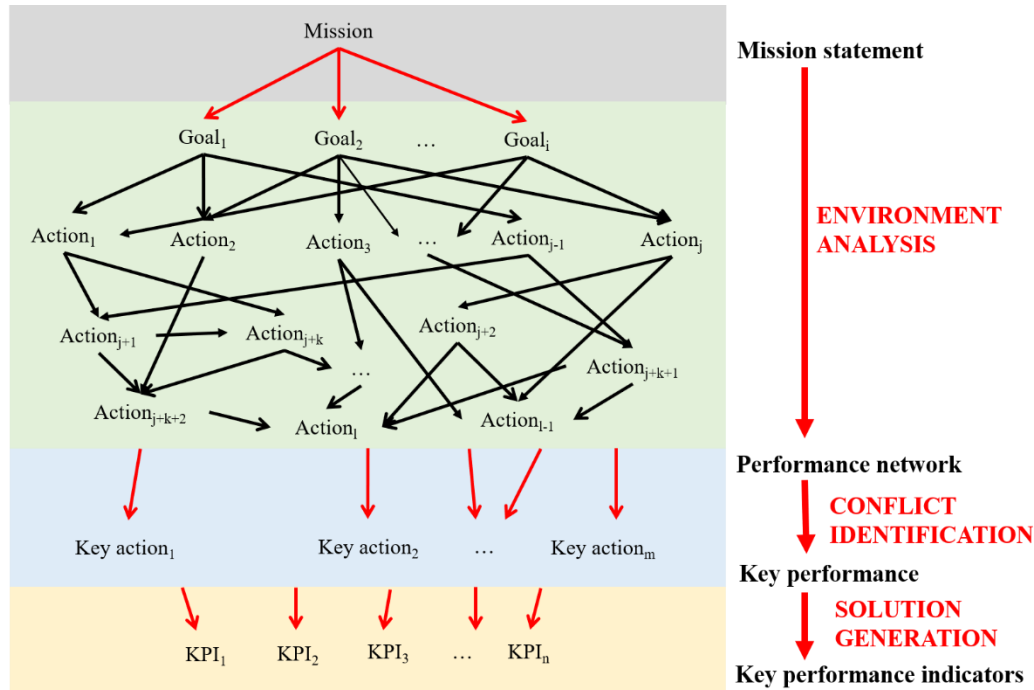
Figure 6: Conceptual structure of KPI development process

Based on the conceptual structure of the KPI development process, two approaches have been developed that both approaches applied EBD methodology. However, Approach A applies the tools and methods provided by EBD, while Approach B only follows EBD's general theory to reduce the complexity and the learning cost for new designers. The two approaches were experimentally tested in the case study to compare the effectiveness and efficiency. The detailed instructions for the procedures and tools of the two approaches are described in the following two subsections, respectively.

The purpose of this case study is to demonstrate the effectiveness and efficiency of the proposed two approaches. By efficiency, it means that the approach does not depend on KPI experts' experience, and non-expert designers can drive the process. This is achieved by asking the right questions to seek the correct answers from the right resources. By effectiveness, we mean that the developed KPI is comparable to the existing validated KPI for the same case.

To achieve the objective above, we will use an airline — Flybe as the case study.

The starting point of the case study is the mission presented in Flybe's annual report. Then we will use EBD enabled KPI development approach to develop a set of KPIs for the company. The developed KPIs will be compared against Flybe's KPIs published on Flybe Annual Report (2018). The validation of the development process will follow the logic below:

1. The EBD enabled KPI development approach can develop critical KPIs from the information included in Flybe's annual report;

2. The EBD enabled KPI development approach applies to the development of any other KPI;

3. The EBD-enabled KPI development approach does not require any knowledge or experience unique to KPI experts. The questions can be generated by non-expert following the EBD-enabled KPI development approach, and the answers to the questions can be sought without challenges in that only reasonable information search and synthesis abilities are sufficient. The answers will exclude information unique to KPI experts.

As the research target, Flybe is the largest regional airline in Europe and a listed company. Therefore, it gives reliable annual reports which contain much information for our analysis. Another reason for using Flybe as an example is that the aviation business is a complex and dynamic environment that can reveal the power of the EBD-enabled KPI development approach in dealing with such an environment. The designer of the KPI is a graduate student who has no experience in the aviation business field. The EBD-enabled KPI development approach was the only method guiding the case study.

The case study was conducted with the designer's common sense, and the data was collected using information searching under the guidance of the proposed approach. Since the case study simulated designing Flybe's KPI, which could be implemented in its 2018/2019 financial year, the searching range of literature and information involved

in this study was limited to a period until 2018. All the information used in this case study was obtained online using the proposed framework, and no extra assistance was acquired during the research.

The designer used various searching engines and databases such as Google, Google Scholar, Web of Science, ProQuest, and researchers' University library as information sources to gather information. They provided access to a large amount of information; however, finding reliable answers distributed in the sea of knowledge became a critical problem for the designer. The problem was solved by applying literature review criteria adopted to the research problem, which is shown in descending order: 1) content (topics or variables), 2) source of information, 3) authors or publishing organization, 4) setting of the paper or report, and 5) research design or sampling methodology (Okoli, 2015). These criteria ensured that the information applied in this case study is reliable.

Before starting the environment analysis process, a stopping rule for the environment analysis has been set to judge the adequacy of the information. This rule includes three clauses:

1. No information is found for a question;

2. The collected information does not apply to the current research target;

3. The collected information may apply to the current research target, but utilizing this information requires assistance from within the target organization or KPI experts.

4.1. Approach A

The procedure of Approach A is shown in Figure 7. It starts with environment analysis to structurally gather information. The initial input, the mission statement as an example, is reformed into a ROM diagram, enabling the designer to determine the keywords for the generation of questions. The rules of ROM are shown in Table 1. By applying the question asking template, a list of questions can be generated based on the

keywords extracted from the ROM diagram. This list guides the designer to search for information in the question-answering step and formulate a list of answers. The answers are then merged and reformulated with simple technical language. The question generation follows the question-asking template provided by EBD (Zeng, 2011), shown in Table 2 and Table 3. Through this step, the designer can interpret the real meaning of the answers according to the research environment and prepare the answers for the next round ROM diagram generation if the answers are not enough to create the performance network in the conflict identification. The steps of environment analysis create an iterative question-driven loop, which could be applied recursively until enough information is gathered. For convenience, a loop starts from ROM generation and gives the list of answers as the output is named a round of question generation and answering (QGA). While the goal of the first round of QGA is usually to reveal the organizational goals underpinning its mission statement, the following rounds of QGA try to dig out what actions should be performed to achieve the organizational goal. The environment analysis comes to an end when the designer thinks enough information has been gathered. This decision should be made based on a predefined rule for the judgement of adequacy of the information.
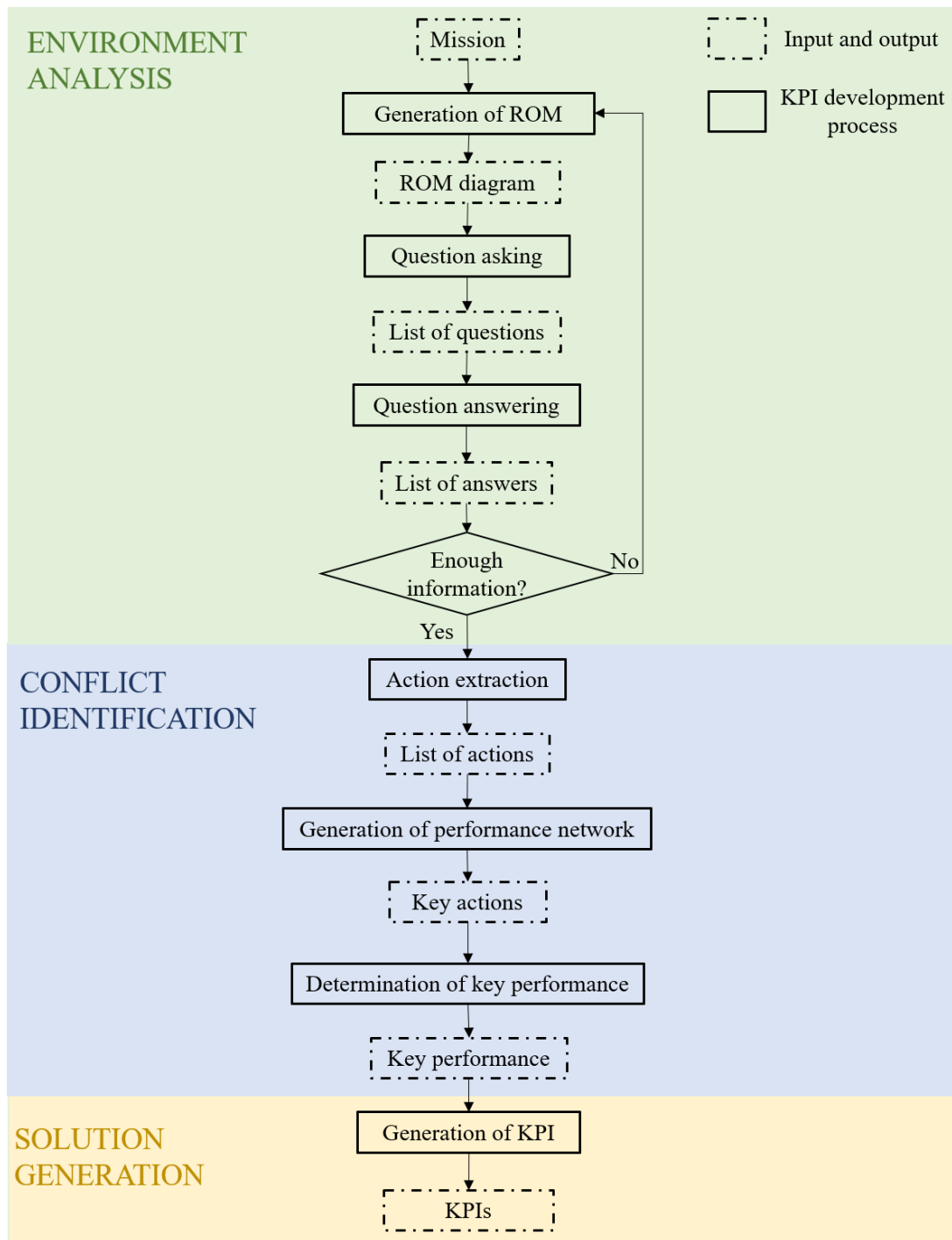
Figure 7: Procedures of Approach A

The conflict analysis involves three steps and starts with extracting actions from the answers generated in the environment analysis. Verbs or gerunds usually indicate actions in texts; however, sometimes, actions could be extracted from descriptions of action. The extraction of actions is a process that translates the actions described in different forms into a uniform type of simple sentence with only one subjective and one

verb in each sentence so that each sentence's simple sentence only describes one action. The verbs in action only appear in active voice. The verbs used in describing actions are strictly limited to the notional verb that link, auxiliary, and modal verb should be eliminated or reformed in the action extraction. As a result, a list of actions is generated and serves as the input for generating the performance network. The performance network diagram illustrates all the actions and the relations between them by connecting them with arrows. Each action is represented by a circle with a code, and the code coincides with the code given in the list of actions. The arrows connecting actions represent the relations between actions. The arrow pointing from action A to action B means A influences B, or A is the premise of B. The performance network can determine key actions, defined as the initial action of one action chain or multiple action chains. Key actions influence all the actions connected by the chain, thus critical to an organization's performance. It is easy to determine the key actions by looking for circles with no arrow pointing to them. An example of the performance network is shown in 错误!未找到引用源。 that action I_1 is the key action. However, not every critical action is controllable because some of the key actions are beyond the range of an organization. The designer must find out what actions are that can be controlled or sufficiently influenced by an organization. The output of conflict identification is a list of controllable key actions. The determination of key actions is the second step of conflict identification. This step is achieved by extracting the environment components from key actions. An environment component appears as a noun in a sentence describing a key action. A phrase that works as a noun in a sentence can also be extracted as a compound environment component or decomposed into several single environment components. When extracting environment components, the designer must consider the real meaning of a noun and combine the environment components represented by different nouns but refer to the same object in the research environment. Some nouns that describe different aspects of an object could be categorized as sub-components under one environment component. A key environment component is a

noun with high frequency appearing in the key performance. For occasions where multiple environment components have a relatively high frequency, a threshold could be applied to determine the key environment components; for example, the top 20% of environment components with the highest frequency could be defined as the key environment components.
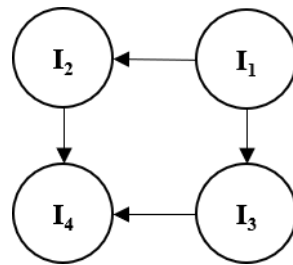
Figure 8: Example of performance network

In the next step, the designer can formulate an organization's key performance using key environment components factors according to the information revealed in environment analysis. This performance describes how an organization should perform to positively influence the key environment components in achieving the organizational mission. After that, the designer can develop KPIs by searching for KPIs practically applied in the industry or consulting domain experts for further information.

Through this approach, KPIs could be developed to form a system that tells the cause and effect of actions based on reliable information dispersed in research articles and reports. The performance network can serve as a roadmap for logically tracing the possible cause and solution when an organization needs to adjust its KPI to improve performance.

4.1.1. Environment analysis of Approach A

The environment analysis starts with Flybe's mission. In Flybe's 2017-2018 annual report, the mission statement is "we are passionate about connecting regional communities, and our aim is to work tirelessly to be the airline of choice for our customers." It is the environment known to the designer at the beginning of the KPI development process.

The mission only gives a general and vague description of Flybe's future goal. The designer identified words that need to be explained using ROM (Figure 9). The question generation follows the question-asking template provided by EBD (Zeng, 2011). During the question generation, the designer first identifies the nouns that need to be explained. When an adjective constrains a noun, a question was raised to ask the adjective and the noun since it is meaningless to explain the environment of an adjective without the corresponding noun. A similar rule applies to an adverb constraining a verb. For verbs, the designer asks how-questions to explain what the verb means in the environment of research. When a domain-specific word appears, questions about its lifecycle and the influencing factors need to be raised. For the detailed question-asking rules, please refer to Zeng (2011). Questions, answers and merged answers are of the first-round QGA are shown in Table 4, Table 5 and Table 6, respectively, as an example of the question generation process in environment analysis.
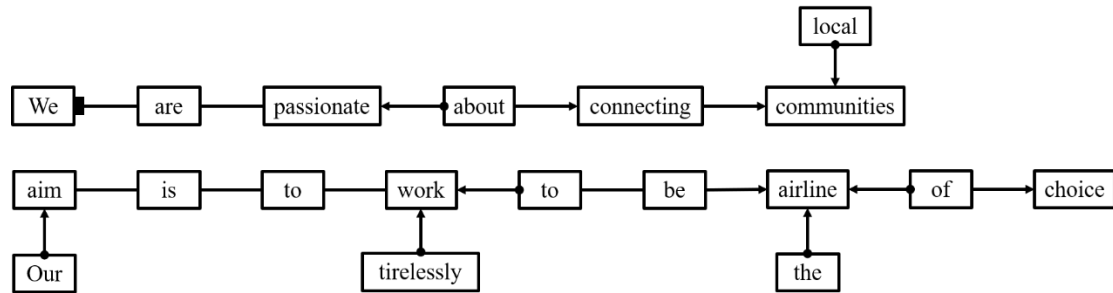
Figure 9：ROM diagram for first round QGA

Table 4: Questions of the first-round QGA in Approach A

No.	Questions
1.	Who are we?
2.	What are regional communities?
3.	What is an airline?
4.	Who chooses an airline?
5.	What is the airline of choice?
6.	How to connect regional communities?

7.   How to become the choice of an airline?

Table 5: Answers of the first-round QGA in Approach A

No.	Answers
1	We refer to the Flybe airline company.
2	Regional communities refer to people who live in towns and cities located in regional areas. These areas are close to regional airports and far away from hub airports (*Flybe Annual Report*, 2018).
3	An airline is a company that operates regular services for transporting passengers and goods by using aircraft ("AIRLINE | meaning in the Cambridge English Dictionary," 2021). The prioritized goals of most airlines are safety, customer service, and profit (Midkif et al., 2004).
4	The customers refer to the passengers of airlines.
5	The airline of choice means customers like the service of Flybe and choose to fly with Flybe.
6	Flybe connects regional communities by operating flights between regional airports and hub airports (*Flybe Annual Report*, 2018).
7	Passengers choose airlines by comparing services between different airlines and transportation means (H.-T. Chen & Chao, 2015; Dennis et al., 2008; Gillen & Hazledine, 2015; Medina-Muñoz et al., 2018; Parrella et al., 2013). Passengers' satisfaction can influence the choice of the customer (Chiou & Chen, 2012; Hussain, 2016; Jou et al., 2008; Ostrowski et al., 1993; Taylor & Baker, 1994).

Table 6: Merged answers for the first-round QGA Approach A

No.	Merged answers
1	Flybe connects regional communities by operating flights to transport goods and passengers living in areas far away from hub airports. The goals of Flybe are profit, safety and passenger satisfaction. Passengers choose airlines by comparing the services of different airlines and transportation means. The satisfaction of passengers influences passengers in choosing airlines.

Through the first-round QGA, the designer has defined the goal of Flybe and explained the meaning of Flybe's mission. However, the information was not enough for the generation of the performance network. The designer applied the same question asking and answering skills in the second-round, third-round and fourth-round QGA until enough information had been found and the stop rule for environment analysis had been triggered. The results are shown in Appendix I. The keywords for the question generation were identified from the merged answers of the previous round of QGA, and these answers became the new environment of KPI development. The exact process was applied in the third-round QGA. The questions are all generated according to the keywords labelled with the red squares in ROM.

4.1.2. Conflict identification of Approach A

The conflict identification was achieved by extracting actions from the information gathered in environment analysis and generating the performance network. The actions extracted from environment analysis answers are shown in Table 7. Actions are usually verbs or gerunds in texts; however, sometimes, actions could be extracted from descriptions of action. The actions should be as simple as possible that there should be only one subject and one verb in action.

Table 7: List of actions in Approach A

Code	Actions
I1	Flybe connects regional communities
I2	Flybe operates flights for the transportation of goods and passengers
I3	Passengers live in areas far away from hub airports
I4	Flybe make profit
I5	Flybe operate flights safely
I6	Flybe make passengers satisfied
I7	Passengers choose airlines
I8	Passengers compare services of airlines, highways, and high-speed trains
I9	The satisfaction of passenger influence passengers' choice of airlines
I10	The white-label service generates revenue
I11	The flight operation generates revenue
I12	MRO generates revenue
I13	The marketing generates cost
I14	The airport generates cost
I15	The staff generates cost
I16	The fleet generates cost
I17	The fuel generates cost
I18	MRO generates cost
I19	The government subsidies influence profit
I20	The regulation influences profit
I21	The competition influences profit
I22	The service improves the satisfaction of passengers
I23	The expectation of passengers influences the satisfaction of passengers
I24	Word of mouth influences the expectation of passenger
I25	Needs of passenger influence expectation of passenger
I26	The desire of passenger influence the expectation of passenger

I27	Experience of passengers influences the expectation of passengers
I28	Passengers' demographic characteristics influence passengers' needs and desire
I29	The safety management systems ensure safety performance
I30	The safety-oriented culture ensures safe performance
I31	Flybe's crew members receive training
I32	Passengers transfer at hub airports
I33	MRO ensures aircraft are in a safe condition
I34	Flybe possesses more specialist capability and labour force
I35	Flybe ensures more professional, efficient, and cost-saving MRO
I36	Flybe provides aircraft, crew, and MRO for White-label service
I37	Flybe generates a service plan
I38	Flybe generates schedule
I39	Flybe allocates resource
I40	Flybe executes plan
I41	Flybe reallocates resource
I42	Fleet influences flight operation
I43	Professional skills of the crews improve the satisfaction of passengers
I44	On-time performance of flight improves the satisfaction of passengers
I45	Efficient check-in process of airline improves satisfaction of passengers
I46	An efficient process for delayed or missing baggage improves the satisfaction of passengers
I47	Airlines use e-commerce tools
I48	Airlines know passengers
I49	Airlines customize the service
I50	Airlines connect flight service and ticketing service
I51	Flybe changes service
I52	Flybe adds new routes to the network

I53	Flybe considers marketing initiatives
I54	Flybe forecasts traffic
I55	Flybe estimates competition
I56	Flybe estimates required resources
I57	Flybe considers the current schedule
I58	Flybe changes the fleet
I59	Flybe changes the size of the crew and distribution of crew bases
I60	Available gates at each airport constrain the schedule generation
I61	Flybe assigns the bidlines to crew members
I62	Flybe assigns aircraft to appropriate rotations
I63	Flybe maintains schedules
I64	Flybe executes flight on time
I65	Flybe reschedules crew members
I66	Flybe responds to irregular operations

The performance network used by the designer for the identification of key actions is illustrated in Figure 10. Arrows connect the actions with interactions. The arrow pointing from action A to action B means A influence B or A is the premise of B. By this way, the designer has generated a nest of actions constituted by several action chains. The key actions are the initial actions of an action chain because these actions could influence all the other actions along the action chains and the result of the actions. The initial actions in the network diagram are those with one or more arrows pointing to other actions but have no arrow pointing to them. The key actions are listed in Table 8.

Figure 10: Performance network in Approach A

Table 8: List of key actions in Approach A

Code	Actions
I2	Flybe operates flights for the transportation of goods and passengers
I8	Passengers compare services of airlines, highways, and high-speed trains
I13	The marketing generates cost
I14	The airport generates cost
I15	The staff generates cost
I16	The fleet generates cost
I17	The fuel generates cost
I19	The government subsidies influence profit
I20	The regulation influences profit
I21	The competition influences profit
I24	Word of mouth influences the expectation of passenger
I27	Experience of passengers influences the expectation of passengers

I28	Passengers' demographic characteristics influence passengers' needs and desire
I29	The safety management systems ensure safety performance
I30	The safety-oriented culture ensures safe performance
I31	Flybe's crew members receive training
I34	Flybe possesses more specialist capability and labour force
I36	Flybe provides aircraft, crew, and MRO for White-label service
I37	Flybe generates a service plan
I42	Fleet influences flight operation
I43	Professional skills of the crews improve the satisfaction of passengers
I44	On-time performance of flight improves the satisfaction of passengers
I47	Airlines use e-commerce tools
I53	Flybe considers marketing initiatives
I54	Flybe forecasts traffic
I55	Flybe estimates competition
I56	Flybe estimates required resources
I57	Flybe considers the current schedule
I58	Flybe changes the fleet
I59	Flybe changes the size of the crew and distribution of crew bases
I60	Available gates at each airport constrain the schedule generation
I61	Flybe assigns the bidlines to crew members
I62	Flybe assigns aircraft to appropriate rotations
I63	Flybe maintains schedules
I65	Flybe reschedules crew members

The list of key actions includes all the actions that can influence organizational performance. However, Flybe only has enough power to control some of the actions. For actions that Flybe could not control, no KPI could be set to guide staff's behaviour and improve Flybe's performance. Thus, the designer has analyzed Flybe's control

power on the key actions and listed the key actions in Table 9 that Flybe can control.

Table 9: List of controllable key actions in Approach A

Code	Actions
I2	Flybe operates flights for the transportation of goods and passengers
I15	The staff generates cost
I16	The fleet generates cost
I24	Word of mouth influences the expectation of passenger
I27	Experience of passengers influences the expectation of passengers
I29	The safety management systems ensure safety performance
I30	The safety-oriented culture ensures safe performance
I31	Flybe's crew members receive training
I34	Flybe possesses more specialist capability and labour force
I36	Flybe provides aircraft, crew, and MRO for White-label service
I37	Flybe generates a service plan
I42	Fleet influences flight operation
I43	Professional skills of the crews improve the satisfaction of passengers
I44	On-time performance of flight improves the satisfaction of passengers
I47	Airlines use e-commerce tools
I53	Flybe considers marketing initiatives
I54	Flybe forecasts traffic
I55	Flybe estimates competition
I56	Flybe estimates required resources

I57	Flybe considers the current schedule
I58	Flybe changes the fleet
I59	Flybe changes the size of the crew and distribution of crew bases
I60	Available gates at each airport constrain the schedule generation
I61	Flybe assigns the bidlines to crew members
I62	Flybe assigns aircraft to appropriate rotations

The key environment components included in the controllable key actions are the resources used by the designer to define the key performance of Flybe. An environment component appears as a noun in a sentence describing an action. Thus, the determination of key environment components was achieved by extracting all the nouns from Table 9 and counting the frequency of nouns. The name of the KPI developing organization is often used as the subject in sentences describing actions; therefore, its name should not be regarded as an environment component. Flybe and airlines were regarded as the organization's name and excluded from the environment components list in this case study. The environment components with higher frequency were considered to be more critical than those with a lower frequency. Some environment components were categorized as the sub-components of an environment component; for example, staff, crew members, labour force, crew, crew bases were categorized as sub-components of staff and written in the parentheses. A threshold could be applied to determine the key environment components when multiple environment components have a relatively high frequency. In this case study, the top 20% of environment components with the highest frequency were defined as the key environment components. As shown in Table 10, the top four nouns with the highest frequency among all 21 nouns were defined as the key environment components.

Table 10: Environment components extracted from controllable key actions

No.	Word	Frequency
1	Staff (staff, crew members, labour force, crew, crew bases)	9
2	Passengers (passengers, expectation of passenger, experience of passenger, satisfaction of passenger, traffic)	7
3	Fleet (fleet, aircraft)	5
4	Schedule	4
5	Flights	2
6	Cost	2
7	Safety performance	2
8	Specialist capability	2
9	Goods	1
10	Safety management systems	1
11	Safety-oriented culture	1
12	Training	1
13	MRO	1
14	White label service	1
15	Service plan	1
16	On-time performance	1
17	E-commerce tools	1
18	Marketing initiatives	1
19	Resources	1
20	Gates	1
21	Bidlines	1

The key performance is deduced with the key environment components based on the information revealed in environment analysis and the performance network generated in conflict identification. The key performance is actions that Flybe should conduct to deliver a good outcome. The designer reviewed information related to the

four key environment components in deduction of the key performance shown in Table 11. Information related to staff indicates that staff plays a critical role in achieving the three goals of Flybe. When professional staff are motivated to engage in their task, Flybe will have better performance. Therefore, Flybe should ensure effective staff training to maintain a professional performance and create a positive organizational climate to motivate staff to engage in their task. In the information related to passengers, passenger satisfaction is most often mentioned as the key factor for an airline's financial performance. Flybe should know the expectation of its passenger and try to keep the passenger satisfaction at a high level. Information about the fleet reveals that the utilization of appropriate aircraft and maintaining a good condition of aircraft could significantly contribute to the safety performance, financial performance and passenger satisfaction at the same time. So that, the designer has selected these two actions as key performances. The schedule is the core of the service plan. A good schedule could make the service plan competitive and contribute to Flybe's profit and passenger satisfaction. To maintain the schedule, Flybe must perform the flight operation on time. Thus, generating a profitable route plan and focusing on on-time performance are two key performances related to the schedule.

Table 11: Key environment components and key performance in Approach A

No.	Key environment components	Key performance
1	Staff	• Ensure effective staff training
		• Create a positive organizational climate
2	Passenger	• Keep a high passenger satisfaction level
		• Know the expectation of passengers
3	Fleet	• Use appropriate aircraft
		• Maintain good condition of aircraft
4	Schedule	• Generate profitable route plan
		• Focus on the on-time performance

4.1.3. Solution generation of Approach A

The solution generation is the last step of the EBD-enabled KPI development approach. The solution generated here is the KPIs for Flybe shown in Table 12. In this step, The designer did not design any new KPI; instead, the KPI generation was achieved by searching for KPIs that have been widely accepted and applied by aviation industries. The searching has resulted in two kinds of outcomes. The designer has found widely used KPIs for key performance No. 2, 3, 4, 7 and 8. Flybe could choose to use one KPI for each key performance or apply multiple KPIs simultaneously to measure the result of a key performance comprehensively. For other key performances, the designer did not find any KPI that can be used to measure the key performance as a whole because these key performances may content various sub-actions, and further analysis needs access to further information of Flybe. Flybe can consult domain experts and provide further information to develop appropriate KPIs.

Table 12: Key performance and KPIs in Approach A

Key performance	KPIs
1. Ensure effective staff training	• Consult experts
2. Create a positive organizational climate	• Employee net promoter score • voluntary turnover rate • Employee absenteeism rate (Davenport et al., 2010; Eldor & Vigoda-Gadot, 2017)
3. Keep a high passenger satisfaction level	• Net promoter score (Bruce et al., 2017)
4. Know the expectation of passengers	• Service Quality (SERVQUAL) • Airline Service Quality (AIRQUAL), • Analysis of travellers' online reviews (Nadiri et al., 2008; Nejati et al., 2009; Zhang & Cole, 2016)
5. Use appropriate aircraft	• Consult experts

6.	Maintain good condition of aircraft	• Consult experts
7.	Generate profitable route plan	• Seat Load factor (Bruce et al., 2017)
		• Yield (Bruce et al., 2017)
		• Block hours per day (Bruce et al., 2017)
8.	Focus on the on-time performance	• Departure punctuality (*KPI Overview*, 2021)
		• Arrival punctuality (*KPI Overview*, 2021)

4.2. Approach B

The procedure of Approach B is shown in 错误!未找到引用源。. The approach starts with environment analysis, and the first step is the question generation using the mission statement as the input. A list of questions is generated to guide the searching of answers in the question-answering step. The output of the question-answering step is a list of answers, which are used as the input in the action extraction. This is an iterative question-driven process of keywords/phrases – asking questions – answering questions applying the question asking template shown in Table 3. In contrast to Approach A, the generation of questions is an intuitive process without using ROM. Designers using Approach B need to identify the word that is not clearly defined in the research environment by carefully reading the text.

Actions and environment components are extracted from answers after each round of QGA. Designers need to consider whether there is enough information for the generation of the performance network. Another round of QGA should be conducted if more information is required. These recursive QGA processes continue until enough information is gathered. A list of environment components and actions is presented as the output of environment analysis. Designers can merge environment components with similar nature into a category according to the research environment. The list of environment components and actions is the input for the performance network. The definition of environment components and actions is identical to that of Approach A. However, Approach B applies a different action extraction method. Actions are usually

verbs or gerunds in texts; however, sometimes, actions could be extracted from descriptions of action. The actions should be as simple as possible that there is only one verb in action. For linking verbs, the action extraction is achieved by extracting the environment components mentioned in the answers, and the actions are described as the "environment components related to something." These actions described the activities of Flybe as a regional airline

In conflict identification, designers need to generate a performance network based on the actions and environment components extracted in the environment analysis. The number of interactions relating to an environment component is the criterion for ranking its criticality. An environment component ranked high in the list could be regarded as a critical component. Designers need to analyze what action of a key environment component is critical to achieving the organizational goal; the key performance is the output of this step. The definition for key environment components and key performance is the same as that of Approach A.

Key performance is the input for the solution generation that the designer reviews the information gathered in environment analysis for the KPIs to guide people in performing the actions identified as critical to achieve the organizational goal. If designers do not have enough information to design a KPI, they can consult domain experts for further help.
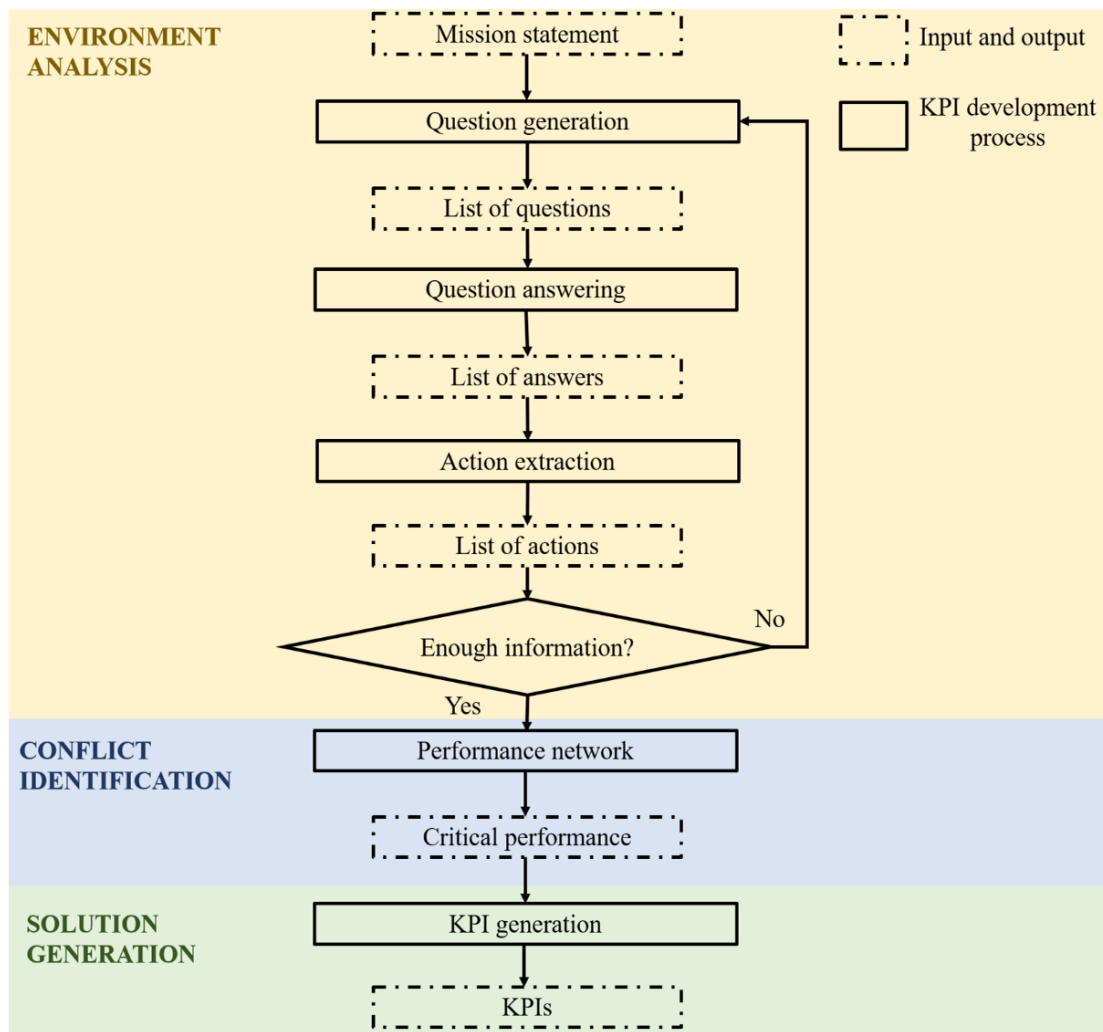
Figure 11: Procedures of Approach B

4.2.1. Environment analysis of Approach B

The environment analysis starts with Flybe's mission. In Flybe's 2017-2018 annual report, the mission statement is "we are passionate about connecting regional communities, and our aim is to work tirelessly to be the airline of choice for our customers." It is the environment known at the beginning of the KPI development process.

The question generation follows the question-asking template shown in Table 3. During the question generation, the first step was to identify the nouns that were not clearly defined. When an adjective constrains a noun, a question was raised to ask the adjective and the noun since it is meaningless to explain the environment of an adjective

without the corresponding noun. A similar rule applies to an adverb constraining a verb. For verbs, the designer asks how-questions to explain what the verb means in the environment of research. When a domain-specific word appears, questions about its lifecycle and the influencing factors need to be raised. Questions and answers of the first-round QGA are shown in Table 13 and Table 14 as an example of the question generation process in environment analysis.

Table 13: Questions of the first-round QGA in Approach B

No.	Questions
1.	Who are we?
2.	Who are the customers?
3.	What are regional communities?
4.	What is an airline?
5.	What is the airline of choice?
6.	How to connect regional communities?
7.	How to become the airline of choice?

Table 14: Answers of the first-round QGA in Approach B

No.	Answers
1	We refer to the Flybe airline company.
2	The customers in the mission statement refer to the passengers of airlines.
3	Regional communities refer to people who live in towns and cities located in regional areas. These areas are close to regional airports and far away from hub airports (*Flybe Annual Report*, 2018).
4	An airline is a company that operates regular services for transporting passengers and goods by using aircraft ("AIRLINE | meaning in the Cambridge English Dictionary," 2021). The prioritized goals of most airlines are safety, customer service, and profit (Midkif et al., 2004).
5	The airline of choice means customers like the service of Flybe and choose to fly with

Flybe.

6   Flybe connects regional communities by operating flights between regional airports and hub airports (*Flybe Annual Report*, 2018).

7   Passengers choose airlines by comparing services between different airlines and transportation means. Passengers evaluate the services of an airline when choosing a flight. The criteria include routes network, safety and punctuality, ticket price, attention and service during the customer journey, other price-related attributes, flight schedule and connections, in-flight space, airline reputation, previous experience, in-flight catering, and entertainment. Airlines ranked high in characteristics mentioned above are more likely to become the choice of airlines (H.-T. Chen & Chao, 2015; Dennis et al., 2008; Gillen & Hazledine, 2015; Medina-Muñoz et al., 2018; Parrella et al., 2013).

Passengers' satisfaction can influence the choice of customers and the reputation of airlines (Chiou & Chen, 2012; Hussain, 2016; Jou et al., 2008; Ostrowski et al., 1993; Taylor & Baker, 1994).

The actions included in the answers to first-round question answering were extracted, which is shown in Table 15. However, this information was not enough for the generation of a performance network. The second-round and third-round QGA was conducted, and the questions and answers are shown in Appendix II. The keywords for the second-round question generation were identified from the answers of the first-round QGA, and these answers became the new environment of KPI development. The same process was applied in the third-round QGA.

Table 15: Actions and environment components extracted from the first-round QGA
in Approach B

Actions	Environment components
1. Airline transport passengers and goods	Airline, passengers, goods, safety, profit, customer service
2. Airline use aircraft	Airline, aircraft
3. Flybe connects regional communities	Flybe, regional communities, regional areas
4. The airline operates flights between regional airports and hub airports	Airline, flight, regional airports, hub airports
5. Passenger evaluate services of airlines	Passengers, airlines, routes network, safety, punctuality, ticket price, attention, services during the journey, other price-related attributes, flight schedule, flight connection, in-flight space, airline reputation, previous experience, in-flight catering, in-flight entertainment
6. Passenger choose flight	Passengers, flights, other airlines, other transportation means

The environment components in the actions were extracted and categorized to prepare for further analysis. Natural environment components refer to objects existing in a natural environment and could significantly influence the actions of the research target. It is the basis for all the actions of the research target. The built environment is objects, organizations, or concepts built by humans and closely relates to the research target. Human environment components are humans or bodies representing a group of humans close relating to the research target. Some built environment components were categorized as the sub-components of a human environment component; for example, customer satisfaction, customer expectation, and passengers' choice were categorized

into passengers. The sub-components are shown in the parentheses. The extraction of environment components is the final step of environment analysis, and the list of environment components is the output of environment analysis.

4.2.2. Conflict identification of Approach B

The conflict identification was achieved by generating the performance network using the information gathered in the environment analysis. In the performance network, environment components were linked according to the actions extracted in the environment analysis. The arrows direct from the initiator of the action and to the receiver of the action. Each line indicates one or more actions between two environment components. 错误!未找到引用源。 shows the Performance network for the case study.
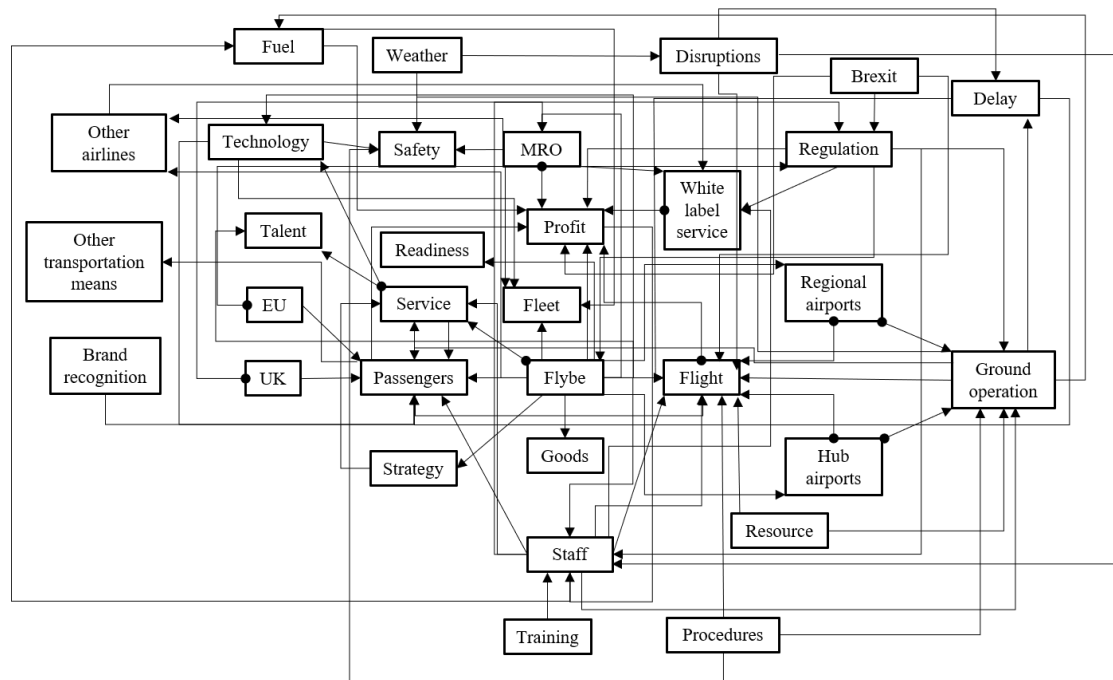
Figure 12: Performance network in Approach B

The performance network was used to identify which environment components were the most critical ones. The extraction of critical environment components was achieved by counting the number of interactions. As the line in the network might indicate more than one action, the number of interactions shown in the performance network was not the only determinant of the criticality. The identification of critical

environment components needs to consider the actual number of actions between two environments components. The five environment components with the most interactions were considered critical in this case study, as shown in Table 16. The environment components ranked higher were considered more critical than those with a lower ranking.

Table 16: Key environment components and key performance in Approach B

No.	Key environment components	Key performance
1	Flybe	• Improve reputation
2	Passengers	• Keep a high passenger satisfaction level
		• Know the demand of passengers
3	Flight	• Generate revenue
		• Focus on the on-time performance
4	Staff	• Ensure effective staff training
		• Create a positive service climate
5	Regulations	• Compliance with safety regulations
		• Monitor the possible regulation change caused by Brexit

4.2.3. Solution generation of Approach B

The key performances and the corresponding KPIs commonly used in the aviation industry are shown in Table 17. The knowledge for the KPI development was gathered in the environment analysis. However, there was not enough information to generate KPIs for all the key performances. For key performance lucking KPI, Flybe can consult domain experts for further information to develop appropriate KPIs.

Table 17: Key performances and KPIs in Approach B

Key performance	KPIs
1. Improve reputation	• Consult experts

2.	Keep a high passenger satisfaction level	• Passenger satisfaction index
3.	Know the expectation of passengers	• Consult experts
4.	Generate revenue	• Cost per available seat kilometres
		• Average revenue collected per passenger kilometre
		• Load factor
5.	Focus on the on-time performance	• Departure punctuality
		• Arrival punctuality
6.	Ensure effective staff training	• Consult experts
7.	Create a positive service climate	• Employee Engagement Index
8.	Compliance with safety regulations	• Consult experts
9.	Monitor the possible regulation change caused by Brexit	• Consult experts

4.3. Compare the effectiveness and efficiency of two approaches

The KPIs developed using Approach A and Approach B are compared with the KPIs developed by experts in Flybe's annual report 2017-2018 in Table 18. Through Approach A, twelve KPIs were developed covering five aspects: passenger satisfaction level, revenue, on-time performance, employee engagement, and passenger expectation. In contrast, seven KPIs were developed through Approach B that four aspects critical to Flybe's performance are covered, including passenger satisfaction level, revenue, on-time performance, and employee engagement. The KPIs developed by experts have five indicators that also cover four aspects, same as Approach B.

Table 19 compared the differences in KPIs. The comparison of the results indicates that the KPIs developed by Approach A and Approach B rival the KPIs given by experts. Moreover, different approaches result in different key performances and different KPIs. Thus, the author could conclude that both approaches can guide the designers in finding the key factors related to the performance of Flybe. In addition, both approaches could help the designers generate knowledge similar to experts and develop the KPIs for an organization.

Table 18: The comparison of KPIs developed through different approaches.

Approach A	Approach B	Experts
• Net promoter score	• Passenger satisfaction index	• Net promoter score
• Seat Load factor	• Cost per available seat kilometres	• Cost per seat
• Yield	• Average revenue collected per passenger kilometre	• Revenue per seat
• Block hours per day	• Load factor	• On-time performance
• Departure punctuality	• Departure punctuality	• Employee engagement index
• Arrival punctuality	• Arrival punctuality	
• Employee net promoter score	• Employee engagement index	
• Voluntary turnover rate		
• Employee absenteeism rate		
• Service Quality (SERVQUAL)		
• Airline Service Quality		

(AIRQUAL)

- Analysis of passengers'

    online reviews

Table 19: The comparison of key performances

Approach A	Approach B
• Ensure effective staff training	• Ensure effective staff training
• Focus on the on-time performance	• Focus on the on-time performance
• Keep a high passenger satisfaction level	• Keep a high passenger satisfaction level
• Create a positive organizational climate	• Create a positive organizational climate
• Use appropriate aircraft	• Improve reputation
• Maintain good condition of aircraft	• Compliance with safety regulations
• Know the expectation of passengers	• Monitor the possible regulation change caused by Brexit
• Generate profitable route plan	• Generate revenue

The differences in the results are produced by the different procedures of the two approaches. Comparing the differences in the KPI development procedures can further demonstrate the efficiency and tell the difference of effectiveness. The nine differences of procedures are shown in Table 20. The first four points show that Approach A is more rule-based in environment analysis and conflict identification. This results from the author's goal in designing the two approaches that Approach A aims to be a rule-based approach by applying EBD theory and tools such as ROM and question-asking template. In contrast, the author wished to simplify the development approach and reduce the difficulty and complexity in learning and using the approach. Therefore, Approach B only follows the EBD thinking but does not strictly apply the tools that the question generation has few rules and relies on designers' personal skills. The difference in points 5-9 determines the effectiveness and efficiency of the results, especially the rules for the performance network in point 5. It determines the performance network of Approach A could be applied in the management of performance. In points 6 and 7, the procedures of Approach B require more effort in each round of QGA compared to that of Approach A. The difference in point 8 makes Approach A more effective and efficient in determining key environment components. The step shown in point 9 makes the

difference between the final results that designers can collect a broader range of information than Approach B. The results of Approach A could measure the organizational performance more comprehensively.

Table 20: Approach A vs. Approach B in procedures

Approach A	Approach B
• Keywords identification by ROM	• Keywords identification by reading text
• Question generation using the question-asking template	• Question generation by asking 5W1H questions
• Answer merging at the end of a round of QGA	• No answer merging requirement
• Key action determination by finding the initial action of an action chain	• No key action determination process
• Performance network based on action chain	• Performance network based on relations between environment components
• Action extraction at the end of environment analysis	• Action extraction after around of QGA
• Environment components extracted from key actions	• Environment components extracted after a round of QGA
• Key environment components extraction from key controllable action by counting frequency	• Key environment components extraction directly from the performance network by counting the number of relations
• KPI creation by searching for new information	• KPI creation by reviewing information collected in environment analysis

Table 21 further demonstrates the differences in the two approaches' design theory by comparing the skills and knowledge required in both approaches. To apply Approach A, designers need to learn more knowledge about ROM and the question-asking template. Approach B only requires designers to learn the rules on the action extraction, information sufficiency and performance network before the application. Other skills required by Approach B are commonly required at the workplace.

Table 21: Knowledge and skills required for two approaches

Approach A	Approach B
• English reading and writing skills	• English reading and writing skills
• Knowledge about QGA template	• 5W1H question skills
• Searching engine using skills	• Searching engine using skills
• Literature review skills	• Literature review skills
• Knowledge about action extraction rules	• Knowledge about action extraction rules
• Knowledge about information sufficiency rules	• Knowledge about information sufficiency rules
• Knowledge about performance network rules	• Knowledge about performance network rules
• Knowledge about ROM diagram	

Through the analysis shown above, the author can conclude that both approaches can guide designers in finding the key factors related to organizational performance and developing the KPIs in dynamic and uncertain environments. Moreover, Approach A is more effective and efficient than Approach B in accomplishing design tasks since Approach A provides a systematic procedure with practical tools enabling the designers to collect a wide range of information while ensuring convergence results. Using approach A, designers can generate KPIs according to the mission and goals of an organization and have a tool — the performance network for dynamically adjusting the KPIs in a fast-changing environment. In contrast, the performance network in Approach B is not constituted by the action chain that an organization can not trace what actions

are influencing a specific organizational performance, not to mention the adjustment of KPIs when the environment changes. Thus, Approach A will be used in future research to develop the questionnaire for studying organizational capability.

4.4. Approach A as a knowledge generation method

The knowledge collected in the case study is from articles, books, reports, and news that could be accessed by searching in the database, such as Google, Google Scholar, Web of Science, Proquest, and Concordia library. No information specific to the KPI development experts were used.

Given the fact that the designer has no background and experience in KPI designing and the aviation industry, we may conclude that with Approach A, similar knowledge could be generated as the experts who developed the KPIs for the target company.

Gibbons and his colleagues categorized two modes of knowledge production (Gibbons et al., 1994; Nowotny et al., 2003). The traditional knowledge production path, called Mode 1 in their work, leads to valid knowledge explaining the natural and social world in a pure academic and mono-discipline manner. This process aims at "inquiry of truth." The Mode 2 knowledge production process is a new discourse with a vital purpose for practical application. The Mode 2 process seeks solutions for complex field problems involving multiple participants with diverse disciplinary expertise and methodologies, aiming to "inquiry of solution." Mode 2 knowledge production has five characteristics: knowledge generated in the application environment, trans-disciplinary, diversity, reflexive, and new form of quality control (Nowotny et al., 2003). Gibbons (1994) explained that "Mode 2" knowledge production is particularly relevant to a practical purpose. The Mode 2 knowledge production process is the "mobilization of a range of theoretical perspectives and practical methodologies to solve the problem" (Nowotny et al., 2003), addressing the diversity of sites and types, which can be understood as diverse participation through communication. The Mode 2 knowledge is produced as a part of the problem to be solved and a part of the environment of

knowledge production (Gibbons et al., 1994; Nowotny et al., 2003). The quality of Mode 2 knowledge is hard to evaluate with previously clear and unchangeable criteria adopted for Mode 1 knowledge. With the diverse participants working on the broader range of complex transdisciplinary problems, evaluation of knowledge produced in such a process needs new quality control systems (Nowotny et al., 2003).

The characteristics mentioned above make Mode 2 knowledge production belong to design activity (Dixon & French, 2020). Kuutti (2007) found "design is an exemplary form of Mode 2 knowledge production". Aken (2005) articulated that knowledge of Mode 2 belongs to "design science" compared with the "explanation science" of the Mode 1 knowledge production process.

The EBD enabled KPI development Approach A applies EBD tools and methods, underpins the approach to producing Mode 2 knowledge. Designers ask questions on the initial design statement and collect the information until enough knowledge is collected to generate the performance network. Designers answered the questions by referring to reliable information resources such as journal papers, textbooks, websites, financial reports. The diversity of the knowledge owners is apparent: researchers, practitioners, consultants, managers, etc. However, the knowledge was not directly provided by experts but collected from open access using EBD tools. In the case study, knowledge on the KPI design was accumulated gradually. Only with the completion of the environment analysis, the whole set of KPIs was figured out. Along with the evolving path of KPI development, the KPIs are subject to questions and answers. We may not assess the KPIs as "right" or "wrong"; instead, "satisfied" or "unsatisfied" with the requirements. In the same line of thinking, the knowledge produced in the KPI design process is situated, dynamic, hardly evaluated with rigid quality criteria. The proposed Approach A is an effective method in generating diverse and trans-disciplinary knowledge for the application's environment. The performance network is not only a form of knowledge but also a new form of quality control for the generation of Mode 2. For an application environment with a long history of application and a

large amount of information accessible to the public, designers using Approach A should be able to generate a performance network to illustrate the relations between the information. If designers could not create a performance network with the collected information in such an application environment, it means the collected information falls short in the quality or quantity to generate Mode 2 knowledge; thus, further information collection process should be performed to improve the quantity or quality of information.

Chapter 5. Case study for OCS measurement using EBD enabled questionnaire design method

To design an effective questionnaire, the first task is to understand what information is required for the problem, opportunity, or decision that needs to be measured by using a questionnaire. No questionnaire can be developed unless the research what information is needed and how that information will be analyzed (Ambrose & Anstey, 2010). Developing a questionnaire design method for the measurement of OCS adaptive to the environment of an organization is possible since people have studied the factors influencing the performance of an organization in different environments. The information about these studies is dispersed in different information sources. A method could guide the questionnaire design by effectively and efficiently collecting the information dispersed in different information sources to find the critical factors of the performance of an organization.

The goal of the case study is to demonstrate how to combine the OCS model and the EBD-enabled questionnaire design method to measure the state of a company. The information came from two primary sources: literature review and the information exchange with the organization's management team through regular meetings. The organization involved in this study is a manufacturing company located in Montreal planning a lean transformation. For confidential reasons, the company's name is represented by Company A. The data used in this study is collected through an anonymous self-report survey that all the members' Company A is the target population of this survey.

5.1. Environment analysis

Organizational change is defined as the effective and efficient change in an organization's structure, composition, or behaviour to respond to the change and turbulence of the environment (Armenakis et al., 1993; Cinite et al., 2009; Holt & Vardaman, 2013). It is accompanied by a high rate of failure, up to 70 percent (Beer &

Nohria, 2000; Washington & Hacker, 2005), even up to 90 percent in other research (S. R. Jacobs et al., 2015). The failure rate is highly related to the type of change (Rafferty & Simons, 2005). Organizational change is divided into first-order change and second-order change. The first-order change is also called incremental change with a small scale and limited impact. The second-order change is also called transformational change, which usually involves the organizational system's change, for example, the routines of working, culture, structure, values, and strategy of an organization (Martin-Fernandez et al., 2007; Rafferty & Jimmieson, 2017).

Based on the information mentioned above, the organization in the case study is planning a transformation that involves a tremendous change in the organization's strategy and routines. In the next round of information searching, we focused on two aspects:

1. How transformational change influences organizational member's perception, affect, knowledge and skills;

2. How organizational members' goal-setting, perception, affect, knowledge, and skills influence their behaviour and performance in organizational change.

The task of the research is "Transfer company A to a lean manufacturing company." The ROM diagram shown in Figure 13 is generated for the analysis of the environment components of the research task. The words in the red square are the environment components that need to be further explained. According to the ROM diagram, questions listed in Table 22 for first-round QGA are generated. The answers to these questions are listed in Table 23.

Figure 13: ROM diagram for the first round QGA for questionnaire design

Table 22: List of questions for first-round QGA for questionnaire design

No.	Questions
1.	What is company A?
2.	What is lean manufacturing?
3.	How to transfer to a lean manufacturing company?

Table 23: Answers for first-round QGA for questionnaire design

No.	Answers
1	Company A is a manufacturing company located in Montreal with three levels of hierarchy: top manager, middle managers and employees.
2	Lean manufacturing is a methodology for operational excellence which is derived from the Toyota Production System (TPS) (Bhamu & Singh, 2014; Patel, 2016; Yadav et al., 2017)
	Lean manufacturing can help a manufacturing company deliver desired products with fewer resources by increasing efficiency, decreasing waste, and continuously improving organizational performance with innovation (Bhamu & Singh, 2014; Charron et al., 2014; Patel, 2016; Yadav et al., 2017).
	The basic building block includes Kaizen, Reduction of Mudas, Jidoka, Just in Time (Patel, 2016; Yadav et al., 2017).
	The lean transformation has three goals. The first goal is to on-time deliver high-quality products with the lowest cost and shortest lead times. This is achieved by engaging the whole value chain from the product design to the delivery of the product. The second goal is to create an effective work environment that employees feel satisfied, safe and treated unbiased at work. The third goal is to enable a company to flexible cope with changing environment through continuous improvement (Bhamu & Singh, 2014; Yadav et al., 2017).
3	The transformation from a traditional manufacturing company to a lean company is achieved by creating a lean culture (Charron et al., 2014; Patel, 2016; Yadav et al., 2017).

Resources are critical to a successful transformation from a traditional manufacturing company to a lean manufacturing company. All leaders should consider resources manage issues when making executive decisions. These resources include human resources, financial resources, knowledge and other resources (Charron et al., 2014; Kuusela et al., 2017; Marshall, 2014).

Organizational leaders should manage the transformation risks by considering the opportunity and threats during the transformation (Charron et al., 2014; Pearce & Pons, 2013).

Lean transformation requires all members of an organization, from top managers to workers, to engage in the transformation (Charron et al., 2014; Patel, 2016; Yadav et al., 2017).

Lean manufacturing is an integrated socio-technical system that can be divided into social and technical systems. (Charron et al., 2014; Yadav et al., 2017).

An education system is necessary to assist the development of social and technical systems by enabling access to the concept and tools of Lean manufacturing and improving learning at the organizational level (Charron et al., 2014; Yadav et al., 2017).

The answers for the first round QGA do not provide enough information to create an interdependence network. Therefore, the answers are merged (Table 24) for the second round QGA.

Table 24: The merged answers of first-round QGA for questionnaire design

No.	Merged answers
1	Company A is a manufacturing company located in Montreal with three levels of hierarchy: top manager, middle managers and employees.
2	Lean manufacturing has three goals. The first goal is to on-time deliver high-quality products with the lowest cost and shortest lead times. The second goal is to create an effective work environment to help employees feel satisfied, safe and treated unbiasedly. The third goal is to enable a company to flexible cope with changing environment through continuous improvement. The basic building block of lean

manufacturing includes Kaizen, Reduction of Mudas, Jidoka, Just in Time.

3   The lean transformation is achieved by creating a lean culture and successfully managing the resources and risks. To create a lean culture, all organizational members need to construct an integrated socio-technological system that can be divided into a social system and a technical system. An effective education system ensures that the organizational members have the necessary knowledge to create an integrated socio-technological system.

The ROM of the answers first-round QGA is shown in Figure 14. Some words that need to be further explained are labelled with a red square. Using the question asking template, the questions for the second round QGA is generated (Table 25), and the corresponding answers are given in Table 26.
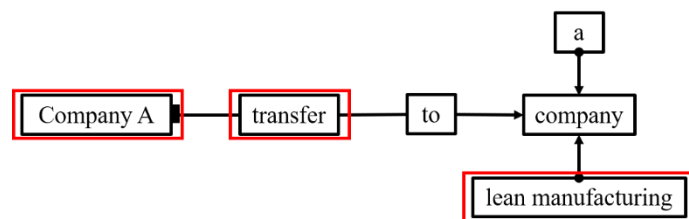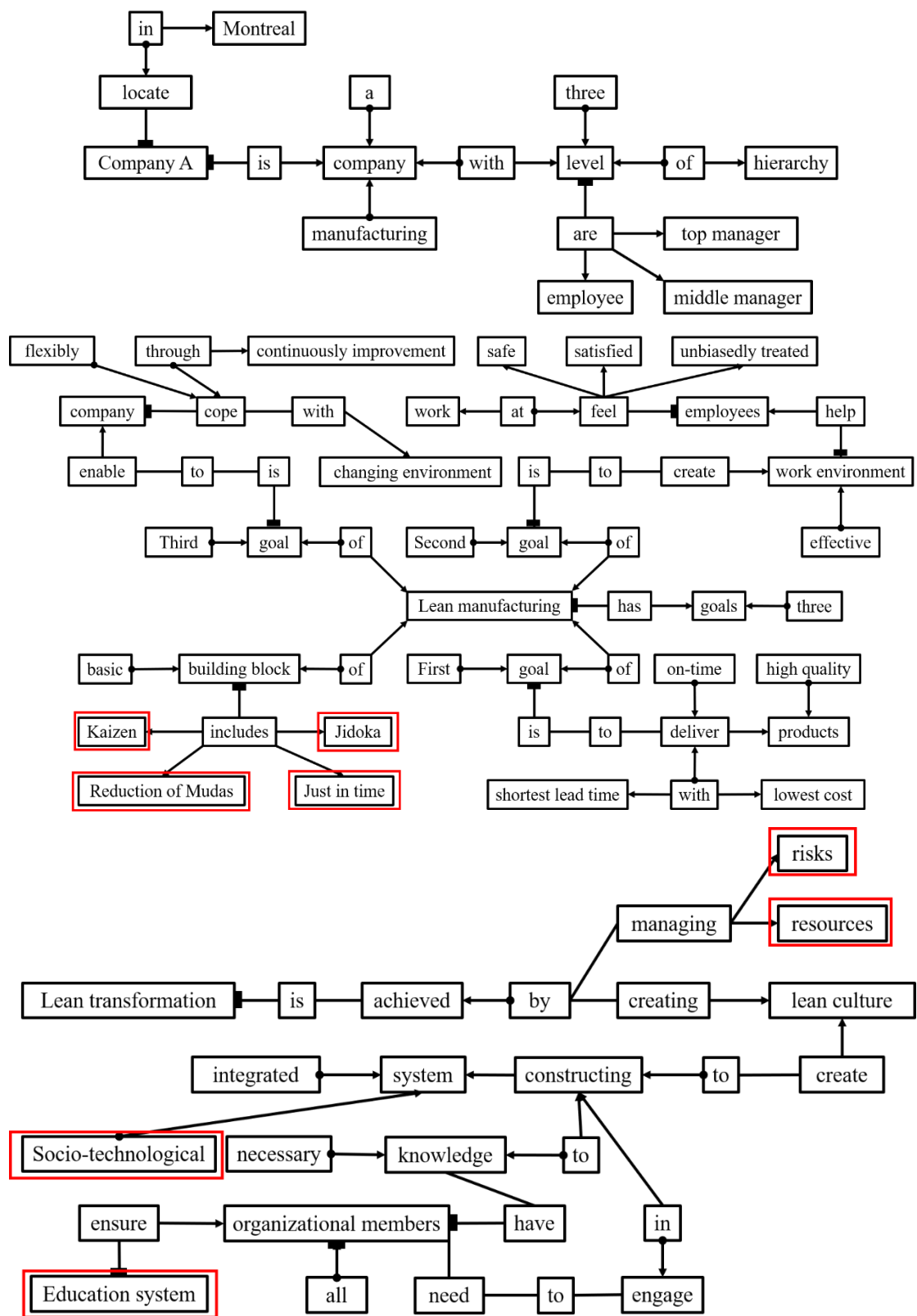
Figure 14: ROM diagram for the second round QGA for questionnaire design

Table 25: Questions of second-round QGA for questionnaire design

No.	Questions
4.	What means Just in time in the context of lean manufacturing?
5.	What means Jidoka?
6.	What means the reduction of Mudas?
7.	What means Kaizen?
8.	What is a socio-technological system in the context of lean manufacturing?
9.	How to manage risks during lean transformation?
10.	How to manage resources during lean transformation?
11.	How to create an education system?

Table 26: Answers of second-round QGA for questionnaire design

No.	Answers
4.	Just in time is one of the two main pillars of the lean. It means to deliver the customer-required products with customer required quality at the customer required time (Charron et al., 2014; Patel, 2016). Just in time is supported by the continuous flow, kanban or pull system, and Heijunka (Charron et al., 2014; Patel, 2016).
5.	Jidoka is a Japanese term for autonomation, one of the two main pillars of the lean. It is an approach to stop the production line to detect and fix error sources when the production line encounters defects (Charron et al., 2014; Patel, 2016). The key for Jikoda is separate human and machine work. This requires standardized work by organizing jobs or tasks efficiently (Charron et al., 2014; Patel, 2016).
6.	Muda is a Japanese term for waste. It is defined as elements or activities that do not add value to the products or services required by customers (Charron et al., 2014; Patel, 2016). There are nine kinds of waste that need to be reduced in lean manufacturing: overproduction, waste time, unnecessary transport time, overprocessing, inventory

build-up, wasted movement, rework and making defective products, unused talent, energy waste (Patel, 2016).

The reduction of muda is a critical part of lean thinking and lean manufacturing (Charron et al., 2014).

7. Kaizen is a Japanese term for "change for the better." In the context of lean, it means continuous improvement (Charron et al., 2014; Patel, 2016).

Kaizen is another critical part of lean thinking and lean manufacturing (Charron et al., 2014).

8. A socio-technical system includes two sub-systems: a social system and a technical system (Charron et al., 2014; Patel, 2016; Yadav et al., 2017).

The social system serves as a behaviour guide for all organizational members. An excellent social system is a trustful and respectful working environment that facilitates organizational members forming consensus and effective communication. It also provides a sense of realism and equal opportunity excellence for organizational members and encourages them to participate in decision-making and engage in a team approach (Charron et al., 2014; Yadav et al., 2017).

A technical system is an assembly of all skills, technologies and tools for the management, planning and problem solving (Charron et al., 2014; Patel, 2016).

9. The implementation can be an opportunity for an organization; however, failed lean implementation wastes the organizational effort and resources and makes further change attempts harder to be accepted by organizational members (Pearce & Pons, 2013).

The general risk management process starts from identifying risk via analysis and evaluating the risk to treat the risk. There is no standard risk management approach for lean transformation. The selection of the risk management method is a scenario-specific task (Pearce & Pons, 2013).

10. There is no standard resources management approach that applies to all lean transformation scenarios. The approach that should be used is specific to an

organization's environment and lean transformation approaches (Patel, 2016).

| 11 | To create an effective education system, an organization should provide the time and resources required for the education system, embrace the lean belief and philosophy, and change to a learning organization. An education system should provide access to all organizational members. Training is an important part of the system (Charron et al., 2014). |

The answers to the second-round QGA provide much information. However, there are some environment components that need to be further specified to gain a more comprehensive view of lean manufacturing; thus, the third round of QGA is conducted. Based on the merged answers shown in Table 27, the ROM diagram in Figure 15 and Figure 16 are generated to assist the raising of questions shown in Table 28 and the gathering of answers shown in Table 29.

Table 27:Merged answers of second-round QGA for questionnaire design

No.	Merged answers
4	Just-in-time means delivering the customer-required products with customer-required quality at the customer's required time. It is supported by the continuous flow, Kanban or pull system, and Heijunka.
5	Jidoka is an approach to stop the production line to detect and fix error sources when the production line encounters defects. The key for Jikoda is separate human and machine work. This requires standardized working by organizing jobs or tasks in an efficient sequence.
6	Muda is elements or activities that do not add value to the products or services required by customers. The reduction of Muda is a critical part of lean thinking and lean manufacturing.
7	Kaizen means continuous improvement. It is a critical part of lean thinking and lean manufacturing.
8	A socio-technical system includes two sub-systems: a social system and a technical system. The social system serves as a behaviour guide for all organizational members.

An excellent social system is a trustful and respectful working environment that facilitates organizational members forming consensus and effective communication. It also provides a sense of realism and equal opportunity excellence for organizational members and encourages them to participate in decision-making and engage in a team approach. A technical system assembles all skills, technologies and tools for management, planning and problem-solving.

9   The general risk management process starts from identifying risk via analysis of the risk and evaluating the risk to treat the risk. There is no standard risk management approach for lean transformation. The selection of risk management method is a scenario-specific task

10   There is no standard resources management approach that applies to all lean transformation scenarios. The approach that should be used is specific to the environment and lean transformation approaches of an organization

11   To create an effective education system, an organization should provide the time and resources required for the education system, embrace the lean belief and philosophy, and change to a learning organization. An education system should provide access to all organizational members. Training is an important part of the system.
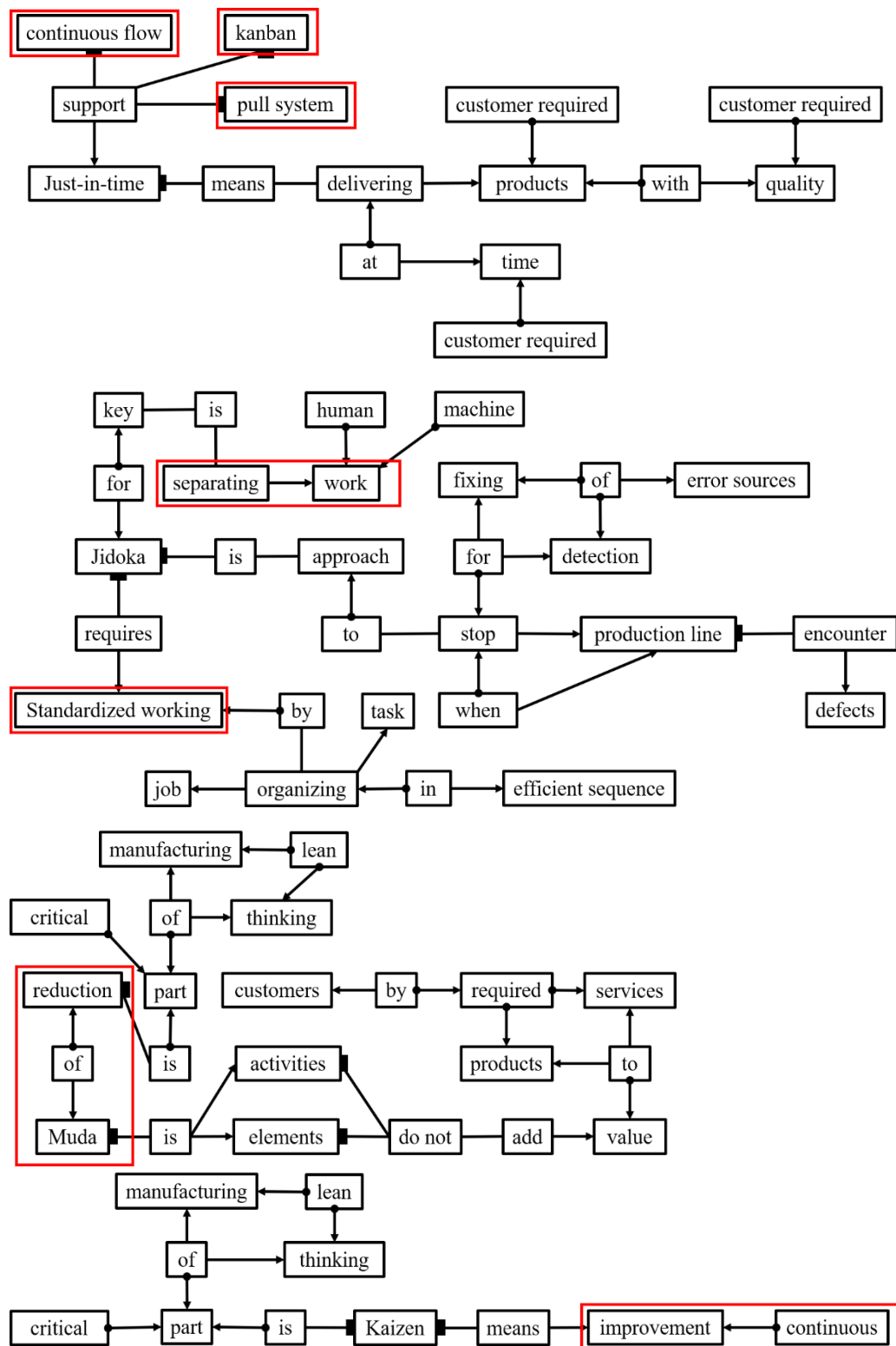
Figure 15: ROM diagram for the third round QGA for questionnaire design part 1
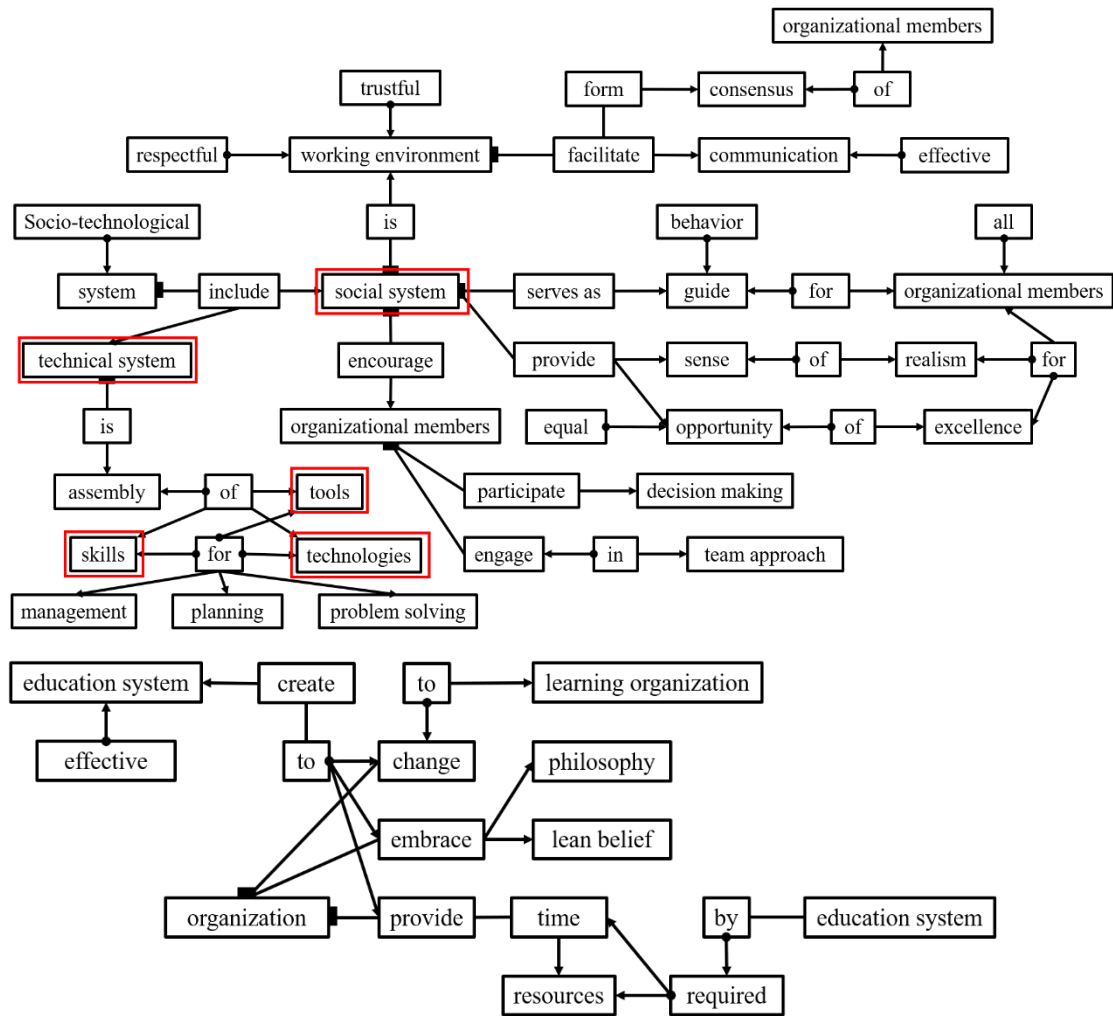
Figure 16: ROM diagram for the third round QGA for questionnaire design part 2

Table 28: Questions of third-round QGA for questionnaire design

No.	Questions
12.	What means continuous flow?
13.	What means kanban?
14.	What is the pull system?
15.	How to separate working?
16.	What means standardized working?
17.	How to standardize working?
18.	How to reduce muda?
19.	How to achieve continuous improvement?

20. What tools can be used for management, planning, and problem-solving in lean manufacturing?

21. What skills can be used for management, planning, and problem-solving in lean manufacturing?

22. What technologies can be used for management planning and problem-solving in lean manufacturing?

23. How to build a social system?

24. How to build a technical system?

Table 29: Answers of third-round QGA for questionnaire design

No.	Answers
12.	Continuous flow means seamless linking of a value-added process to minimize transport time or storage buffers (Charron et al., 2014; Patel, 2016). There is no standard process for all organizations to establish continuous flow. Tools, technologies, and abilities of organizational members (cross-trained workers) are the basic prerequisite for a continuous flow (Patel, 2016; Rother & Harris, 2001).
13.	Kanban is a signal system used in a pull system. It contains information about the number, name, and quantity of required products (Charron et al., 2014; Patel, 2016). There are many methods and models for the creation of the Kanban system for an organization. This requires an organization to adapt the tools of Kanban to its specific environment and situation (Charron et al., 2014; Lage Junior & Godinho Filho, 2010; Sendil Kumar & Panneerselvam, 2007).
14.	A pull system is a cascading production that starts from the last operation station of a production line. A product is produced and delivered only when the downstream customers signal the upstream suppliers. In this way, the excess inventory is minimized (Charron et al., 2014; Patel, 2016). Various tools can be used to develop a pull system (Pedrielli et al., 2015; Renna et al., 2013). There is no comprehensive guideline for the implementation of a pull system.

The implementation of a pull system needs to consider the specific condition of an organization.

15. No information found

16. Standardized work is the current best process to complete a task after evaluating different ways to accomplish tasks. Workers repeat the standardized work to minimize the variability of the pace and processes of work (Charron et al., 2014; Patel, 2016).

17. An organization standardizes the work by creating standard work instructions for organizational members. Different kind of work requires different kinds of standard work instructions (Charron et al., 2014).

18. Different organizations may have different waste, but the type of waste is similar. To reduce waste, organizational members should first learn to identify waste and then use appropriate tools and strategies to eliminate the identified waste (Charron et al., 2014).

19 Continuous improvement means continuously changing to a better way of manufacturing. The change could be Kaizen (small changes) or Kaikaku (revolution). Continuous improvement is a critical goal of lean transformation. To achieve continuous improvement, organizations need to encourage the organizational members to engage in the change and use appropriate tools and technologies to enable the change (Charron et al., 2014; Patel, 2016).

20 There are many tools for achieving lean manufacturing. Due to many available works of literature, organizations need to appropriately choose tools for the process that need to be transferred to a lean manner (Bhamu & Singh, 2014; Charron et al., 2014; Patel, 2016).

21 Lean manufacturing is achieved by organizational members' mindset and behaviour change to adopt lean belief and lean work processes. This requires organizational members to have many skills and knowledge to perform new tasks and cope with the change from the old system to the new system. These skills can be required by training, communication and coaching (Charron et al., 2014; Patel, 2016).

22 There are many kinds of technologies that can be used for lean manufacturing, such as

technologies for knowledge sharing, communication, supply chain, etc. organization need to appropriately choose tools for the process that need to be transferred to lean manner (Bhamu & Singh, 2014; Charron et al., 2014; Patel, 2016).

23   To build an effective social system, an organization should select the right people and train organizational members to be equipped with the lean mindset and the knowledge, technologies, and skills to implement lean. This process starts with top managers and involves all the organizational members to accept the lean culture. All organizational members should be motivated to learn and implement principles, concepts, knowledge, skills and technologies about lean. Leaders should act as supporters and coaches to help subordinates in the collective learning by monitoring the working process and communicating with workers (Patel, 2016; Sisson & Elshennawy, 2015; Yadav et al., 2017).

24   There is no standard approach for the creation of a technical system. Various tools can be implemented in a lean manufacturing company. The key is to choose appropriate tools (Yadav et al., 2017).

The third round of QGA advances the information searching to a level where no standard answers can be found, and many answers need specific information of company A. This requires further discussion with company A to access the information not included in the current research stage. Moreover, through three rounds of QGA, enough information is gathered to create an interdependence network. The two conditions mentioned above meet the stop rule of the environment analysis phase. Thus, the environment analysis ends after the third round of QGA, and the questionnaire design identifies conflicts.

5.2. Conflict identification

Conflict identification starts from the extraction of actions from the information gathered in the environment analysis. Actions are usually verbs or gerunds in texts; however, sometimes, actions could be extracted from descriptions of action. The actions should be as simple as possible that there should be only one subject and one verb in

action. Table 30 shows the thirty-eight actions extracted from the answers generated in the environment analysis phase.

Table 30: Actions extracted from the answers gathered in QGA

Code	Actions
I1	Company A transfers to a lean manufacturing company.
I2	Company A delivers desired products with fewer resources.
I3	Company A increases efficiency.
I4	Company A decreases waste.
I5	Company A continuously improves organizational performance with innovation.
I6	Company A creates an effective work environment.
I7	Organizational members of company A feel satisfied, safe and treated unbiased at work.
I8	Company A copes with changing environment.
I9	Company A creates A lean culture.
I10	Leaders successfully manage resources.
I11	Leaders successfully manage risks.
I12	All organizational members engage in the transformation.
I13	Company A integrates the social system and the technical system into a socio-technical system.
I14	Company A creates a lean social system.
I15	Company A creates a lean technical system.
I16	Company A creates a lean education system.
I17	Company A becomes a learning organization.
I18	Leaders identify risks in lean transformation.
I19	Leaders analyze risks in lean transformation.
I20	Leaders evaluate risks in lean transformation.
I21	Leaders solve risks.
I22	Leaders provide time and resources for the education system.

I23	All organizational members receive training.
I24	All organizational members have access to the education system.
I25	All organizational members use appropriate tools and technologies.
I26	Organizational members adopt the lean belief and lean philosophy.
I27	Organizational members have the skills and knowledge for new tasks and new systems.
I28	The top manager changes its structure.
I29	Leaders identify the problems in the current working process
I30	Leaders understand lean the principles and concepts of lean.
I31	Leaders set organizational goals.
I32	Leaders impress the importance of the organizational goal to subordinates
I33	Employees understand the goal of their department.
I34	All organizational members have strong motivation and high satisfaction levels.
I35	Leaders support subordinates.
I36	Leaders coach subordinates.
I37	Leaders monitor the working process.
I38	Leaders communicate with subordinates.

Based on the 38 actions shown in Table 31 and the relations between these actions, the performance network is generated, shown in Figure 17. Arrows connect the actions with interactions. The arrow pointing from action A to action B means A influence B or A is the premise of B. By this way, the designer has generated a nest of actions constituted by several action chains. The key actions are the initial actions of an action chain because these actions could influence all the other actions along the action chains and the result of the actions. The initial actions in the network diagram are those with one or more arrows pointing to other actions but have no arrow pointing to them.
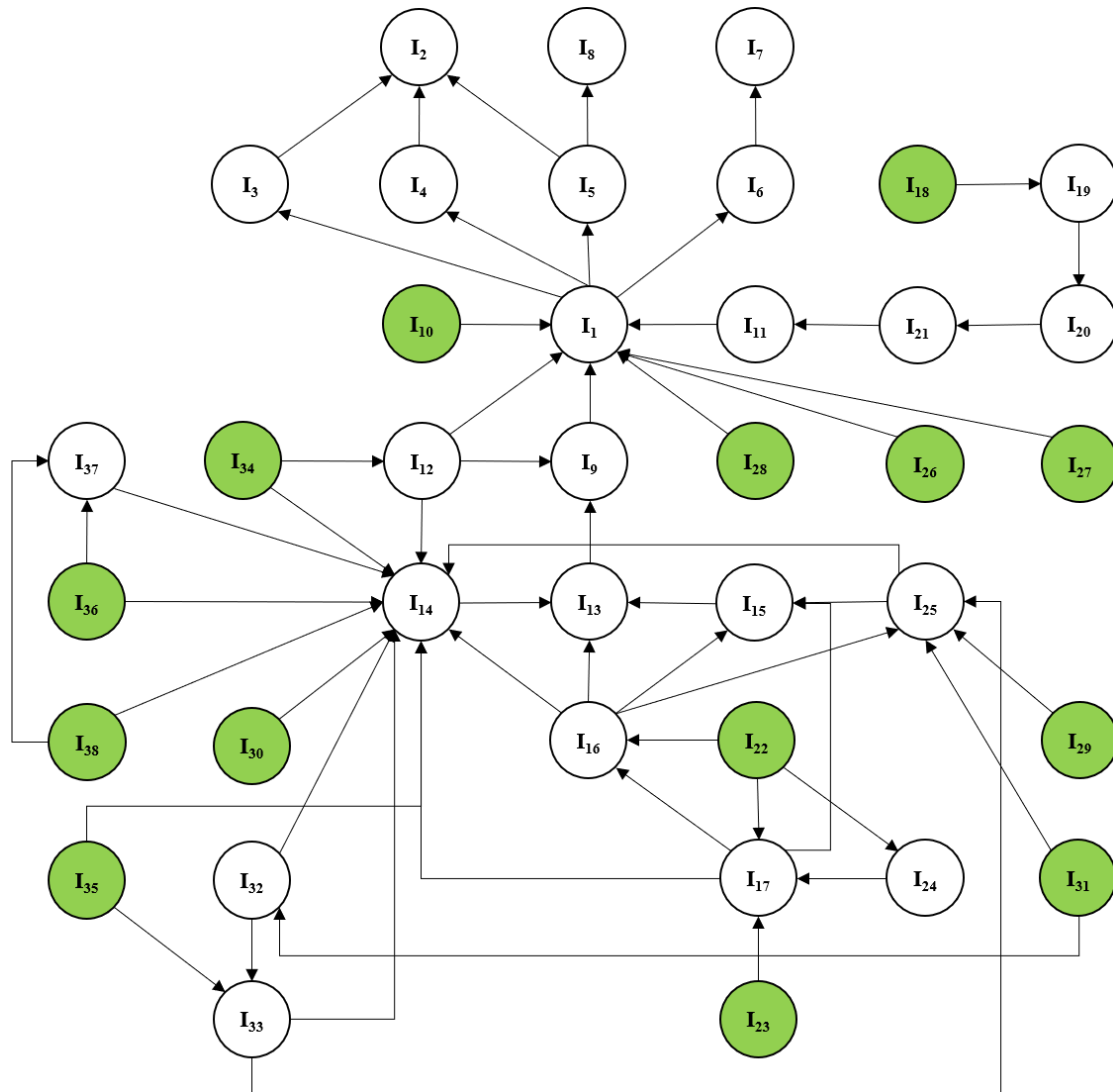
Figure 17: Performance network for questionnaire design

Table 31: Key actions for questionnaire design

Code	Actions
I10	Leaders successfully manage resources.
I18	Leaders identify risks in lean transformation.
I22	Leaders provide time and resources for the education system.
I23	All organizational members receive training.
I26	Organizational members adopt the lean belief and lean philosophy.
I27	Organizational members have the skills and knowledge for new tasks and new systems.

I28	The top manager changes its structure.
I29	Leaders identify the problems in the current working process
I30	Leaders understand lean the principles and concepts of lean.
I31	Leaders set organizational goals.
I34	All organizational members have strong motivation and high satisfaction levels.
I35	Leaders support subordinates.
I36	Leaders coach subordinates.
I38	Leaders communicate with subordinates.

The list of key actions includes all the actions that can influence organizational performance at the beginning of a lean transformation. However, to develop the questionnaire for the analysis of OCS of company A, a questionnaire designer should determine what knowledge, skills, goals, perception and affect should be measured in the questionnaire. This is achieved by categorizing the environment components included in the key actions into the four perspectives for the item generation: goal, knowledge and skills, perception and affect. In addition, company A is an organization with three levels of organizational members, and each organizational member has his or her tasks specific to their level in the hierarchical structure of company A. Thus, the categorization of environment components considers the type of environment component in the OCS system and the organizational members whose relation to the environment component is revealed in the key actions. Table 32 shows the environment components that are categorized according to above mentioned two rules. In addition to the four categories in the OCS system, an additional category — supportive actions are also included in the table, which indicates the actions required for the initial stage of a lean transformation. The critical environment components serve as the guide line for the item generation in the solution generation phase.

Table 32: Key environment components

	Employees	Middle manager	Top manager
Goal	• Individual goal	• Department goal • Individual goal	• Organizational goal • Individual goal
Perception	• Strong motivation • Perceived workload change	• Lean belief • Lean philosophy • Perceived workload change • Strong motivation	• Lean belief • Lean philosophy • Strong motivation
Emotion	• High satisfaction level	• High satisfaction level	• High satisfaction level
Knowledge and skills	• Training • Skills and knowledge for new tasks	• Risk • Resources • Training • Skills and knowledge for new tasks • Problems in the working process • Lean concepts and principles	• Risk • Resources • Training • Skills and knowledge for new tasks • Structure of the company • Problems in the working process • Lean concepts and principles
Supportive actions		• Support for subordinates • Coaching subordinates • Communication with subordinates	• Support for subordinates • Coaching subordinates • Communication with subordinates

5.3. Solution generation

The phase after conflict identification is solution generation. In this phase, items are generated according to the key environment components. This is achieved by using the information gathered in environment analysis and searching for new information for item generation.

The through conflict identification phase, the information required for assessing the OCS state for Company A's lean transformation is defined. However, for a deployable questionnaire, four layers need to be further improved according to Labaw's questionnaire design method (Labaw, 1981).

Layer 1 is the words. Precise wording is the basic requirement for an effective questionnaire. It should appropriately express the meaning of each question. Minor variation in the wording usually has little effect on the respondents' understanding of a question if the same basic concept, overall approval or disapproval of a specific problem is measured.

Layer 2 is the type and quality of questions. In general, two types of questions can be used in a questionnaire — open-ended and closed questions. Open-ended questions leave the space for the respondents to let them form their responses by using their own words, while respondents answer the closed questions by choosing selections given by questionnaire designers. Closed questions require questionnaire designers to be able to estimate and code the possible answers. It is easier for respondents to choose answers than form their answers, especially for attitude questions. The quality of a questionnaire can be good or bad. Bad questions are, for example, incomprehensible questions that respondents cannot understand or unanswerable questions, including questions that may cause misunderstanding. The questionnaire designer should pay great attention to ensure the questions have high quality.

Layer 3 is the format or layout. Questionnaires are formatted to meet the demands of:

1. Obtain accurate respondent meaning (asking multiple questions per topic and

putting questions within the questionnaire into some orderly sequence to avoid position bias).

2. Provide smooth flow and modulated transitions throughout the interview topic to topic.

3. Aid the interviewer in following the branching, exclusions, and sequence of questions incorporated into the questionnaire.

4. Provide a good format for the accurate tabulation of the data.

Layer 4 is item development. It is the starting point of all questionnaire designs. Items define what to measure and how to measure.

5.3.1. Items development

Company A's organizational members have different key environment components, and the same environment component may have different meanings in different working environments; thus, three questionnaires need to be designed for each level of hierarchy. Three different questionnaires are designed according to the environment of the organizational members since tasks, work processes, and work environment are specific to the position of individuals within the organization. In this process, the questionnaire designer should bear in mind that the goal of a questionnaire is to collect real data from potential respondents. The category of key environment components and the questions for each topic are shown in the following parts of this section.

Category 1: Goals of employees

Employees in manufacturing companies usually have a very detailed working process and explicit goals. They only need to consider individual goals at working. Two items are generated to measure their current goal and their expectation after the transformation:

E1. What is the current objective of employees' work?

E2. What is the expectation after the transformation?

Category 2: Perceptual state of employees

To motivate employees, an organization should consider the factors that influence employees' readiness to engage in the transformation process (Madsen et al., 2005). The readiness to change can be divided into two subdimensions: the collective commitment to conduct the change (change willingness) and the collective belief in achieving the goal of the change (change confidence) (Sanders et al., 2017). Members of an organization with high organizational readiness to change share the perception that they recognize the change as necessary and worthwhile and are confident in themselves in performing the task necessary to implement change (Hallett & Hoffman, 2014; Hatjidis et al., 2019; Sanders et al., 2017). The workload change is a major concern of employees during the organizational change. The change of workload is a by-product of organizational change. It could happen before, during, and after the organizational change (Smollan, 2015). An increase in workload may lead to the organizational member's non-supportive attitudes towards the change (Vakola & Nikolaou, 2005). An increase in workload enhances the negative affect aroused by the perceived workload during the change (DiStaso & Shoss, 2020). To measure the motivational level and the perception of possible workload change induced by the transformation, three items are generated:

E3. Are employees willing to change to the use of a lean working process?

E4. Are employees confident about the transformation?

E5. How do they perceive the potential influence of the transformation on the workload?

Category 3: Emotional climate of employees

Job satisfaction is a kind of emotion that could influence employees' performance, especially when the change is very intensive or very frequent (Lindorff et al., 2011; Rafferty & Griffin, 2006). Job satisfaction is negatively correlated to the work stress of individuals. The work stress derives from the disequilibrium between the perceived demand of work and the insufficient individual capability for the work (Martin-

Fernandez et al., 2007). Sub-scales of job satisfaction are used in recent research to investigate employees' job satisfaction in organizational change such as pay, benefits, promotion, supervision, co-workers' contingent rewards, operating procedures, nature of the work, and communication, where pay and promotion are the two most influential factors of the job satisfaction (Claiborne et al., 2013; Parlalis, 2011). To measure the satisfaction level, three items are developed:

E6: Are employees satisfied with their current status?

E7: Are employees satisfied with the pay?

E8: Are employees satisfied with the promotion chance?

Category 4: State of knowledge and skills of employees

Training is required to help employees gain knowledge and skills to adopt the new structure, routine, culture, and technology introduced in the change. Besides, the gain of task-oriented knowledge and skills during change helps employees to have a comprehensive view of the change and reduces uncertainty (Garner, 2009; Miller et al., 2006). To give appropriate training, an organization should define who needs training and what training they need (Patel, 2016). Two items are generated to measure the training needs and the knowledge and skills acquired by employees:

E9. Do employees need training?

E10. What knowledge and skills do they have to achieve their individual goal?

The social environment also influences organizational members' perceptions such that informal groups consisting of co-workers are important sources of cues for the generation of perceptions. Previous research shows that co-workers' beliefs and attitudes influence the effectiveness of organizational actions and individual perceptions on the change (Rousseau & Tijoriwala, 1999; Stackhouse & Turner, 2019; Stinglhamber et al., 2020). Series of questions asking the attitude of co-workers' or subordinates are also developed to gather data on co-workers' perception. These items can reveal the state of communication between employees. They can also serve as an

indicator for the accuracy of the answers that if the average score of the colleagues' perception is close to that of employees' self-report perception, the responses are true and reliable.

E11. Are the colleagues confident about the transformation?

E12. Are the colleagues willing to change to the use of a lean working process?

E13. Are the colleagues satisfied with the current status?

Category 5: Goals of middle managers

Middle managers are leaders of different departments in an organization. They align the department goal with the organizational goal and lead the employees to achieve the department goal under their supervision. Three items in respect with the goal of middle managers are created:

M1. What is the current individual goal of middle managers at work?

M2. What is the current goal of middle managers' departments?

M3. What is the future goal of middle managers' departments?

Category 6: Perceptual state of middle managers

Similar to employees, middle managers need to be active to engage in the transformation. This requires the middle manager to consider lean transformation a necessary step towards a better organization and be ready for the change. A state of readiness means they are willing to engage in the change and have confidence in it. To achieve the transformation, they should discard the old mindset and embrace the lean belief and lean philosophy (Charron et al., 2014). The change of perceived workload may also influence the willingness to transform; thus, the assumption of the workload change should be considered in assessing middle managers' perceptions. Four items are created to measure the perception of middle managers:

M4. Are middle managers willing to change the organization into a Lean enterprise?

M5. Are middle managers confident about the transformation?

M6. Do middle managers believe the transformation is necessary?

M7. How do the middle managers assume the workload change after the transformation?

To achieve the lean transformation, middle managers must discard old beliefs and embrace the Lean belief and philosophy. Two items are generated to test how middle managers perceive the lean belief and philosophy:

M8. What kind of benefits can be brought by the Lean transformation?

M9. How can the lean transformation improve their departments?

Category 7: Emotional state of middle managers

Managers with high satisfaction levels are more likely to engage in the transformation. Similar to employees, the promotion chance and pay are the two most influential factors influencing the middle managers' emotions towards the change. Two items are developed to measure the satisfaction level:

M10. Are middle managers satisfied with their current status?

M11. Are middle managers satisfied with the pay?

M12. Is there a fair promotion opportunity for middle managers within the organization?

Category 8: State of knowledge and skills of middle managers

To adapt to the changing working environment, middle managers need new skills and knowledge (Patel, 2016). Lean concepts and principles are necessary knowledge for middle managers to perform lean management (Charron et al., 2014; Patel, 2016). As leaders, middle managers' tasks also involve identifying risks and problems and managing resources for the transformation. These aspects are covered with the following items:

M13. How do middle managers understand lean concepts and principles?

M14. What are the risks middle managers identified?

M15. What are the current problems middle managers identified?

M16. What resources do middle managers require for transformation?

Category 9: Supportive actions of middle managers

In a lean organization, leaders should support and coach to improve subordinates' performance and align subordinates' goals to the organizational and department goal (Charron et al., 2014; Patel, 2016). To measure the supportive actions of middle

managers, one item is generated to measure the points mentioned above:

M17. Have the middle managers given any support to employees so far?

In a lean organization, leaders should communicate with the subordinates (Charron et al., 2014; Patel, 2016). This helps leaders understand their subordinates' perception towards the transformation and needs for engaging the upcoming change. eight items are generated to measure the points mentioned above:

M18. Do middle managers' subordinates have a fair workload?

M19. Are middle managers' subordinates satisfied with their current status?

M20. Can middle managers' subordinates correctly perceive the department goal?

M21. Are middle managers' subordinates' confident towards the transformation?

M22. Are middle managers' subordinates willing to engage in the transformation?

M23. Do middle managers' subordinates have enough knowledge and skills?

M24. Do middle managers' subordinates need training related to lean transformation?

M25. What are the main work responsibilities of middle managers' subordinates?

Category 10: Goals of the top manager

The top manager is the most influential decision-maker in an organization. It is the responsibility of the top manager to set the goal for the whole organization. Two items in respect with the goal of middle managers are created:

T1. What is the current individual goal of the top manager at work?

T2. What is the current goal of Company A?

T3. What is the future goal of Company A?

Category 11: Perceptual state of the top manager

The top manager is the final decision maker to decide whether an organization embarks upon the lean transformation. As the highest organizational member in the hierarchical structure of an organization, the top manager should perceive the transformation as a necessary process for its organization to be more competitive in the

market. The change of workload may also influence the top manager's perception of the change. Two items are created to measure how top managers perceive the necessity of the lean transformation and workload change induced by the transformation:

T4: Do top manager perceives the change as a necessary process for Company A?

T5. How does the top manager assume the workload change after the transformation?

To achieve the transformation, the top manager should discard the old mindset and embrace the lean belief and lean philosophy (Charron et al., 2014). Two items are generated to measure whether the top manager has embraced the lean belief and philosophy:

T6: What kind of benefits can be brought by the Lean transformation?

T7. How can the lean transformation improve the performance of Company A?

Category 12: Emotional state of the top manager

Pay is an influential factor for the top manager's job satisfaction. Since there is no chance for the top manager to be promoted in Company A, pay becomes the most critical aspect of job satisfaction. Two items are generated:

T8. Is the top manager satisfied with the current status?

T9. Is the top manager satisfied with the pay?

Category 13: State of knowledge and skills of the top manager

Lean concepts and principles are necessary knowledge for the top manager to perform lean management (Charron et al., 2014; Patel, 2016). As the leader of the whole organization, the top manager's tasks also involve identifying risks and problems and managing resources for the transformation. The lean transformation requires an appropriate organizational structure to adapt to the new work process and technologies implemented in an organization. The top manager should take the responsibility to consider how the organization should be structured to empower the organizational members in performing new tasks in a lean organization. These aspects are covered with the following items:

T10. How does the top manager understand lean concepts and principles?

T11. What are the risks the top manager identified?

T12. What are the current problems the top manager identified?

T13. What resources top manager requires for transformation?

T14. How does the top manager think about the organizational structure?

Category 14: Supportive actions of the top manager

In a lean organization, the top manager should act as a supporter and coacher. One item is generated to measure the support given to subordinates:

T15. Has the top manager given any support to the subordinates so far?

In a lean organization, the communication with subordinates is very supportive actions of leaders (Charron et al., 2014; Patel, 2016). This helps the top manager understand whether the subordinates are ready for the transformation and what the subordinates need to engage in the upcoming change. To measure the supportive actions of middle managers, six items are generated to measure the points mentioned above:

T16. Do the top manager's subordinates have a fair workload?

T17. Are top manager's subordinates satisfied with current status?

T18. Are the top manager's subordinates confident about the transformation?

T19. Are the top manager's subordinates willing to engage in the transformation?

T20. Do the top manager's subordinates have enough knowledge and skills?

T21. What are the main work responsibilities of the top manager's subordinates?

5.3.2. Layout adjusting

The questionnaire starts with the closed attitude questions, which ask the respondents to choose the scale best representing their attitudes. This can help respondents easily start the question answering. The opened questions appear at the end of the questionnaire to dig out the background information.

Some attitude questions may suffer from the social desirability response bias, for example, the willingness toward the change. For these questions, a double-check

technique is used in this question. Employees are asked to report their attitude towards the change and colleagues' attitudes towards it for the employee questionnaire. When an employee gives a similar attitude to both questions, the answers can be regarded as reliable. The reliability of the answers can be further checked by calculating the organizational climate for both types of questions. If the average ratings of both types of questions are close, then the attitude is regarded as reliable. To avoid the social desirability response bias, middle managers' attitude is measured by asking top managers about subordinates' attitudes instead of directly quiring middle managers. The same technique is used to measure the support given by supervisors. The measurement of middle managers' supportive actions is achieved by asking employees what support they have received. For the top manager's support, the respondents are middle managers. The communication between employees and middle managers is also measured through indirect questions. The middle managers are asked about the attitude and emotions of their direct subordinates. The answers will be compared with the answers given by employees to identify the effectiveness of the communication between middle managers and employees.

The effect of the sequence of questions on the responses is called context effects. This effect appears strong when respondents consequently answer questions on the attitude about the same issue. If the prior answer is negatively loaded, the answer for the subsequent question will also be negatively loaded. A sequence of questions about the same issues is also prone to suffer from screening items. To reduce the context effect and the effect of items screening, the order of questions in the questionnaire for Company A are rearranged to measure the real attitudes of respondents.

5.3.3. Question type Selecting

Considering the difference in the responsibility and working environment of organizational members at different hierarchies of Company A, different question type of selecting strategy is selected. For employees, most questions are closed questions to

reduce their workload in the survey, as they are more passive in the change process than leaders. The questionnaires for leaders content more open-ended questions to dig out the background information. One criterion for determining question type is whether the possible answers can be estimated and pre-coded during the questionnaire design. A 5-point Likert-type scale is applied for closed attitude items, where 1 represents strongly disagree with the statements, and 5 represents strongly agree. Some of the closed items also provide space for respondents to explain their thoughts in detail. This could help us gather more information about the driving force behind the responses.

5.3.4. Adjust wording

The wording adjustment focuses on the appropriateness of questions. This is achieved through discussion with the management team of Company A and adjusting the words to fit the research environment, for example, using "market recognition" to represent the "pay." The final product is the three questionnaires shown in Appendix III. A summary of items in each questionnaire and its corresponding questions in the questionnaire is given in Table 33.

Table 33: Items in each questionnaire

Questionnaire	Category	Item	Question No.	Question type
Employees	Goal	E1	13	Open-ended
		E2	14	Open-ended
	Perception	E3	1	Closed
		E4	2	Closed
		E5	8	Closed
		E11	3	Closed
		E12	4	Closed
	Emotion	E6	7	Closed
		E7	5	Closed
		E8	9	Closed

		E13	6	Closed
	Knowledge	E9	10	Closed
		E10	12	Closed
	Supportive action	M17	11	Closed
Middle managers	Goal	M1	19	Open-ended
		M2	21	Open-ended
		M3	23.1	Open-ended
	Perception	M4	7	Closed
		M5	4	Closed
		M6	1	Closed
		M7	10	Closed
		M8	18	Open-ended
		M9	16	Closed
	Emotion	M10	11	Closed
		M11	6	Closed
		M12	12	Closed
	Knowledge	M13	14, 15, 23.2	Closed
		M14	17	Open-ended
		M15	24	Open-ended
		M16	23.3	Open-ended
	Supportive action	M18	3	Closed
		M19	9	Closed
		M20	8	Closed
		M21	2	Closed
		M22	5	Closed
		M23	13.1	Closed
		M24	13.2, 13.3	Closed

		M25	22	Open-ended
		T15	20	Closed
Top manager	Goal	T1	14	Open-ended
		T2	16	Open-ended
		T3	17	Open-ended
	Perception	T4	1	Closed
		T5	7	Closed
		T6	13	Open-ended
		T7	20	Open-ended
	Emotion	T8	8	Closed
		T9	5	Closed
	Knowledge	T10	9	Closed
		T11	12	Open-ended
		T12	19	Open-ended
		T13	18	Open-ended
		T14	10	Open-ended
	Supportive action	T16	3	Closed
		T17	6	Closed
		T18	2	Closed
		T19	4	Closed
		T20	11	Open-ended
		T21	15	Open-ended

5.4. Survey

The questionnaires were distributed in paper form by managers to encourage organizational members to participate in the survey. The responses were submitted in a box by the respondent him/herself and directly collected by the researcher. In this way, the respondents anonymously answer the questionnaire when they feel comfortable and

are away from the work environment's influences. This survey method could reduce the socially desired responses and increase the response rate. Forty-four respondents have returned their questionnaires, including forty employees, three middle managers, and one top manager, resulting in a response rate of about 22%. The current statistical analysis is based on employees ' responses because of the respondents' small sample size from middle managers and top managers. The analysis of middle managers' responses is achieved using descriptive data. The top manager's responses will not be statistically presented to comply with the confidentiality agreement. These results will be used as a baseline in the analysis.

5.5. Assessment

5.5.1. Top manager

The top manager participated in the survey. Due to the confidentiality principle, the responses from the top manager are not shown in this thesis. However, the analysis of the responses from the top manager is used as the baseline for the assessment of organizational capability state.

5.5.2. Middle managers

The responses for perceptual measuring items are shown in Table 34. Middle managers show a neutral attitude towards the transformation that they believe the organization is already transferred to a lean manufacturing company that only some improvement is needed but not a transformation. They are willing to contribute to the change but not confident in the transformation, and they believe their subordinates are willing to change the company to a lean organization have little confidence in the transformation. There is a difference in middle managers' answers on the perception of the potential workload change induced by the transformation that one believes the change will bring more workload while two others think the workload will remain the same. The answers for possible benefits that could be brought by the transformation

and expectation for the transformation have revealed the difference in the perception of lean belief and philosophy. One middle manager correctly perceived the belief and philosophy of lean, while the other two managers believe lean is to cut cost. The responses to the questions on perceptual state answers illustrate that middle managers are in general willing to change but are not confident in the change. Only Manager A regards the change as necessary and correctly perceives the lean philosophy, while the other two middle managers simply regard the lean transformation as a method for reducing cost; thus, there is no need to conduct the transformation. In general, no middle manager shows a strong positive perception towards the change, despite Manager A correctly perceiving lean manufacturing philosophy.

Table 34: Middle managers' perception

Question	Manager A	Manager B	Manager C
• Transformation is necessary	Agree	Neutral	Neutral
• Have the confidence to change	Neutral	Disagree	Neutral
• Have the willingness to change	Neutral	Agree	Agree
• Workload change after transformation	More workload	No change	No change
• The expectation for the department	Correctly perceive lean	Cost reduction	Cost reduction
• Benefits can be brought by lean	Become more efficient by sharing knowledge inside the my team and with other teams. Provide or obtain support to support the highest priorities for the business	Cost reduction	Short term cost reduction

The responses about the goal-setting of middle managers are shown in Table 35. All respondents clearly understand their work responsibility; however, only Manager A

integrates lean thinking into the work responsibility. Both Manager A and Manager B have a clear plan for their department at the current stage and general expectations for the change. In contrast, Manager C does not have a clear department plan at the current state nor any expectation for the transformation. From the responses, it is evident that Manager A has clear goal-setting with integrated lean thinking than Manager B, while Manager C lacks clear goals for the department and does not understand the organizational goal.

Table 35: Middle managers' goal setting

Question	Manager A	Manager B	Manager C
• Work responsibility	A clear goal with integrated lean thinking	A clear goal without lean thinking	A clear goal without lean thinking
• Current department goal	A clear plan for the department	A clear plan for the department	No clear plan
• Expectation after the change	Clear general expectation	Vague general expectation	None

Table 36 shows the responses for the questions on the emotional state question. The results indicate that Manager B and Manager C have a very similar emotional state in that they are satisfied with the salary and current status. Moreover, they both believe there is promotion chance in the organization, but rare. Conversely, Manager A gives neutral answers to the market recognition and current status and believes there is a fair chance for the promotion within Company A. Despite the differences in the responses, all three middle managers have a positive emotional state.

Table 36: Middle managers' emotional state

Question	Manager A	Manager B	Manager C
• Fair Market recognition	Neutral	Agree	Agree
• Satisfied with the current status	Neutral	Agree	Agree
• Promotion chance	Fair chance	Rare chance	Rare chance

From the responses for the state of knowledge and skills of middle managers (Table 37), it is evident that Manager A and Manager C have a more comprehensive understanding of the lean concepts and principles than Manager B. Every middle manager has their understanding of risks, current problem and resources for the transformation. This knowledge is clearly influenced by their perceptions towards the change that the responses of Manager B and Manager C are related to cost reduction and possible downsizing. Both managers do not know what they should do to achieve their department's goals in such a situation. In contrast, the responses indicate that Manager A has a more objective understanding of risks, resources, and the actions required to achieve the goal. The general knowledge state correlates with middle managers' perception that a more positive perception leads to a more subjective understanding of risks, resources, and current problems. The knowledge of lean concepts and principles is not the decisive factor for subjective understanding.

Table 37: Middle managers' knowledge and skills

Question	Manager A	Manager B	Manager C
• Prerequisites for transformation	1. Understanding the goals of lean change for everyone 2. Recruit lean experts	1. Understanding the goals of lean change for everyone	1. Understanding the goals of lean change for everyone 2. Recruit lean experts 6. Lean culture

		4. Consultation from specialists in the lean change management field		
•	Skills needed for achieving the department goal	1. Professional designation 2. Working experience 3. Leadership 4. Project management skill	2. Working experience	2. Working experience 3. Leadership 4. Project management skill
•	Risk/challenge in the transformation	1. Limited time 2. Uncertainty in workload and resources 3. Uncertainty from stakeholders' expectation	1. Team moral for possible changes in jobs.	1. Losing expertise
•	Necessary actions	1. Clear metrics 2. Support for resources allocating	No idea	No idea
•	Resources required	Time and facilitator for change	Low-cost resources	No idea
•	Current problems could be solved by transformation	Obtain manpower and expertise	Headcount and wrap rate	Cash and cost

The responses for the supportive actions (Table 38) illustrates how the middle managers perceive and understand their subordinates. Middle managers generally think

their subordinates are willing to change but not confident and are neutral to the current status. This coincides with the perceptions of employees towards the change. The high correlation between managers' self-report perception towards change and managers' reports on employees' perception towards change shows that the measurement of managers' perception is reliable. They all believe subordinates need training, especially the knowledge about lean. Moreover, they can clearly state the work responsibility of their subordinates. The results reveal that middle managers can understand the perception of their subordinates through communication, although their subordinates cannot perfectly perceive the task assigned by the middle managers. However, employees report that they receive little support from middle managers. This is similar to the middle managers' report on the support from the supervisor.

Table 38: Middle managers' supportive actions

Question	Manager A	Manager B	Manager C
• Subordinates' confidence	Neutral to change	Not confident to change	Neutral to change
• Subordinates' workload	Fair workload	Not fair workload	Fair workload
• Subordinates' willingness	Neutral to change	Willing to change	Wiling to change
• Subordinates can correctly perceive the goal	Agree	Neutral	Neutral
• Subordinates' current status	Neutral	Neutral	Neutral
• Subordinates' training needs	Subordinates need training	Subordinates need training	Subordinates need training
• Subordinates' training type	1. Knowledge about lean	1. Knowledge about lean	1. Knowledge about lean

	2. Knowledge related to their job after transformation. 3. Vision of where we want to be after the change		
• Support from supervisor	Little support	Some support	More pressure
• Work responsibility of subordinates	Clear understanding	Clear understanding	Clear understanding

5.5.3. Employees

The interrater reliability and interrater agreement calculation were achieved by analyzing variance (ANOVA test) using the Turkey test in the homogeneity of variance test with significance at $p < 0.05$. Cluster analysis using Hierarchical Cluster Analysis was achieved by applying Ward's method with Squared Euclidean distance index. For the 5 point Likert-scale attributes and binary attributes, the range of clustering solutions is from 2 to 4 clusters. Descriptive analysis such as frequency, mean, standard deviation, and percentage were also used to present the survey results. All the analysis in this research was achieved by using SPSS statistical software.

There are 36 effective employees' responses, from which the organizational climate is calculated. As shown in Table 39, there are four climate dimensions, three of which measure the attitude of co-workers and respondents themselves, while the other one only measures the respondents' attitude. The Cronbach's α ranges from 0.785 to 0.881, showing high reliability of the measurement. The ICC(1) values range from

0.102 to 0.205, and the ICC(2) values range from 0.891 to 0.949, reporting medium reliability of a single response and high reliability of an aggregated mean. Only the "confidence to change" gets a high average r_{wg} larger than 0.7, while the other three dimensions have a moderate r_{wg} ranging from 0.684 to 0.692. The results indicate that the perceptions on these four dimensions aggregate to an organizational climate, and the measurement, responses, and the mean value of aggregation are reliable.

Table 39.Climate dimensions

Dimension	α	ICC(1)	ICC(2)	r_{wg}	Average r_{wg}	Item
Willingness to change	0.786	0.102	0.891	0.701	0.692	1.You are willing to change to the use of a lean working process.
				0.684		2. Your colleagues are willing to change to the use of a lean working process.
Confidence to change	0.881	0.205	0.949	0.712	0.740	1.You are confident towards the transformation.
				0.767		2.Your colleagues are confident about the transformation.
Satisfaction to current status	0.785	0.161	0.932	0.636	0.690	1.You are satisfied with your current status.
				0.696		2. Your colleagues are satisfied with their current status.

Satisfaction to market recognition	0.684	0.684	1. You are fairly recognized compared to the average market level.

The correlation matrix shown in Table 40 provides more evidence for the questionnaire's reliability that only items in the same dimensions report high correlation. This further confirms the reliability of the responses as the rating on the respondents' attitudes and co-workers' attitudes show a high correlation. The mean score of items depicts the elevation of organizational climate that a score higher than 3 indicates a positive attitude. The rating on "willingness to change", "satisfaction to current status" and "self-satisfaction to market recognition" report positive attitudes. Especially the "willingness to change" reports a high mean score. Only the rating on the "co-workers' confidence to change" shows a negative attitude. This data indicates that employees welcome the change and are moderately satisfied with the current status and market recognition. However, employees are not very confident in the change.

Table 40. Descriptive statistics and correlations (N=36)

Correlation matrix									
	Mean	SD	1	2	3	4	5	6	7
1. Self-willingness to change	4.111	0.785	1.000	-	-	-	-	-	-
2. Colleagues' willingness to change	3.417	0.806	0.647	1.000	-	-	-	-	-
3. Self-confidence to change	3.250	0.770	0.378	0.012	1.000	-	-	-	-

4. Colleagues' confidence to change	2.917	0.692	0.281	0.218	0.791	1.000	-	-	-
5. Self-satisfaction no current status	3.056	0.791	0.312	0.411	0.352	0.374	1.000	-	-
6. Colleagues' satisfaction to current status	3.222	0.866	0.215	0.314	0.257	0.318	0.649	1.000	-
7. Self-satisfaction to market recognition	3.083	0.806	0.211	0.209	0.426	0.474	0.261	0.259	1.000

All correlations have a significance level of $P<0.05$

As shown in Figure 18, a three-group solution for the cluster analysis is chosen to illustrate subgroups within employees according to their perceptions. Group A, with 26 members, includes members possessing positive attitudes on all the dimensions. However, they are almost neutral on the co-workers' confidence in the change and the market recognition. The second group has eight members willing to engage in the change and cautiously confident about the change. They are different from group A employees, mainly in the last four dimensions that Group B employees think their co-workers have no confidence in the change and are not satisfied with the market recognition. Besides, they are not satisfied with their current status, and they believe their co-workers hold the same perception. The third group has only two members who reported negative attitudes on all dimensions, and their attitudes were close to group B employees on satisfaction and market recognition.
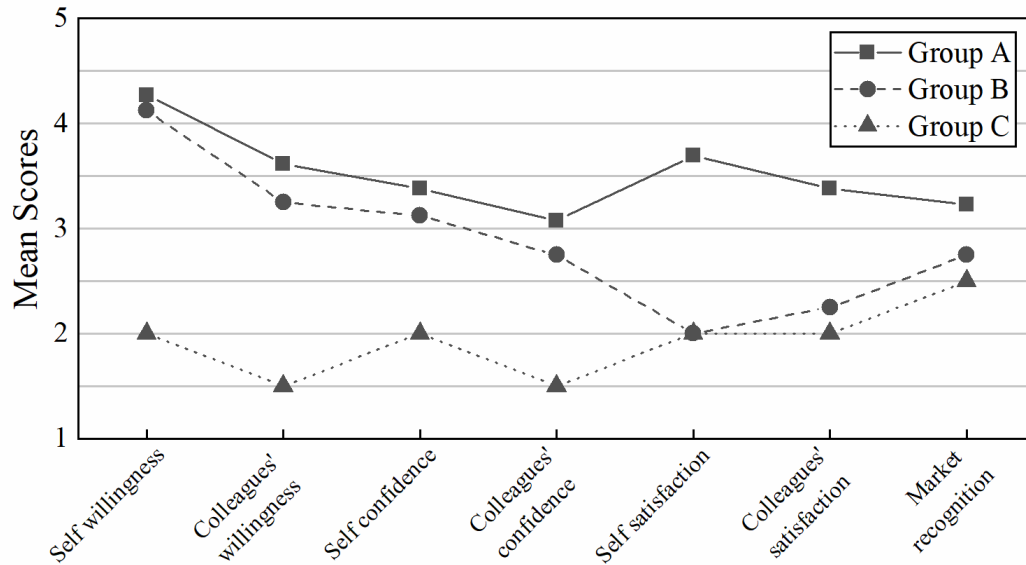
Figure 18. Shape profile of three clusters climate

The responses on training needs, superior support, and individual goal are illustrated in Table 41. Employees in group A reported strong needs for training and a low ratio in receiving superior support. Over half of them had individual goals. The employees in group B reported a higher ratio in training needs and have individual goals, but a lower ratio in superior support than group A employees. Only one employee in Group C had individual goals, while no need for training and superior support was reported. In total, 69.44% of employees needed training relating to change, and 55.56% of employees had their individual goals. However, only 13.89% of employees believed that they received superior support in work.

Table 41: Clustering for binary attributes

Clusters	Frequency	Need Training	Receive Superior Support	Have Individual Goal
A	26	69.23%	15.38%	53.85%
B	8	87.50%	12.50%	62.50%
C	2	0%	0%	50%
Total	36	69.44%	13.89%	55.56%

The estimation of the workload during change is shown in Table 42. Most people thought they could not estimate the change. However, nine employees thought the workload would increase, and six employees thought it would remain the same as the current workload. Only one employee thought the workload would be reduced after the change. This indicates that most of the employees did not expect a reduction of workload during the change.

Table 42: Estimation of the change of workload

Responses	Frequency	Percentage
Increased workload	9	25%
No change	6	16.7%
Reduced workload	1	2.8%
No idea	20	55.6%
Total	36	100%

As shown in Table 43, most employees agree that there is a chance for promotion, but rare for employees. Nine employees report that they have no chance for promotion within the organization. Only one employee believes that there is a fair chance for promotion. It is rather apparent that most employees do not think they would have a promotion chance under the current conditions.

Table 43: Promotion chance

Responses	Frequency	Percentage
Yes, fair	1	2.8%
Yes, but rare	26	72.2%
No chance	9	25%
Total	36	100%

Figure 19 shows the knowledge and skills owned by employees. Relevant experience and qualifications receive the most responses, followed by the team player and good problem-solving skills. Language skills and analytical skills are also widely spread skills. Over half of the respondents believe they are creative, while over one-

third of employees report having emotion management, project management, and negotiating and influencing skills. These responses evidence that employees may have knowledge and skills for their current tasks. However, the transformation requires employees to acquire good problem-solving skills, be team players, be creative, and manage emotion during the transformation. The training for such topics is necessary to enhance the knowledge and skills of employees.
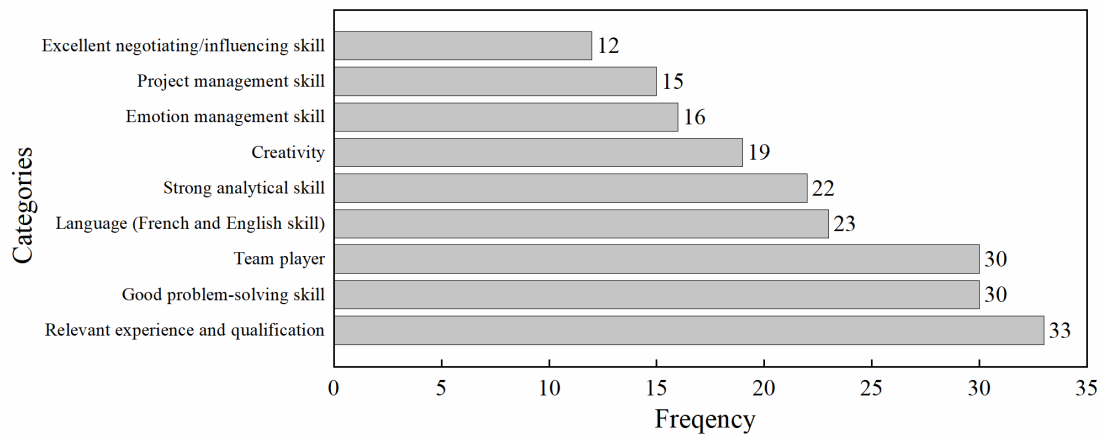
Figure 19: Knowledge and skill of employees

Compared to closed items, the open-ended items receive a lower response rate. However, these items provide a way to uncover important information that cannot be precoded in closed items by offering the organizational members a chance to tell their concerns in their own words. Among the 19 employees who explained why they need training in their own words, 18 said they need to be trained to understand the change plan and how it will impact their job. A similar trend was found in the 22 employees who described what support they had received from their supervisor and what kind of support they needed from their supervisor. Also, 15 out of the 22 employees emphasized the importance of supervisor support to clarify the details of the change procedure', and all these 15 respondents said they did not receive support from their supervisor. There were 26 effective responses to the item asking about employees' current goals, and 21 responses were coded as having a clear understanding and sufficient knowledge for the current goal. Finally, among the 30 responses to the item inquiring about the expectation on change, 14 were hoping for a more effective working process and a more effective

organization, while 7 of them had no expectations because of the lack of detailed information about the change.

The survey results show that the employees of the company form a climate to the change. In general, the employees were willing to see a change in the company. Despite that, their confidence in the change is weak. This indicates a moderate change readiness. In addition, employees were neutral to the current status and the salary level of the company. Employees formed three sub-groups holding different perceptions of the change. The largest group is group A that employees were willing and confident to change, and they were satisfied with current states and salaries. Employees in group B showed relatively high interest in change and neutral confidence, but they were not satisfied with the current status and salaries. Employees in the smallest group showed very low willingness and confidence to change and low satisfaction with the current status and salaries. There is no huge gap between the employees' responses in group A and group B in employees' opinions on the need for training, superior support, and individual goal. Both groups reported that most employees needed training relating to the change and knew their current goals. However, only a small part of employees reported that they received superior support in daily work. Employees in Group C did not need training and received no support from superiors. In general, most employees are interested in training on how the change will impact their work. Over half of employees know their current goals. However, a tiny part of employees perceived support from superiors. About the estimation of workload and promotion chance, most employees could not estimate the workload change and believed there was a chance for employees to be promoted but rarely available for employees.

Taking all information together, the employees in the target company fell short of the knowledge and skills related to the change. This state is further evidenced by employees' needs for training and supervisor support to help them understand the change and how to make it. Employees have knowledge and skills to perform their current tasks, but they need specific knowledge and skills to understand and do their

work in the change. Employees formed a positive climate to the change that they were willing to change, but neutral in confidence to change and the satisfactory level to the current status and market recognition. This is due to the uncertainty of the change caused by the ambiguous goal and procedure of the change. The lack of detailed information about the change makes it hard for employees to estimate the possible impact on the workload that employees' stress and feeling of uncertainty have increased. From the open-ended responses of employees, we found that the company has recently experienced several rounds of change. Some employees perceived last changes simply as downsizing that they projected previous experience and were unwilling to see the change. This climate may hinder organizational members from sufficiently using their knowledge and skills in implementing the change. In contrast to employees, managers were less willing to see the change and more satisfied with their current status. They were not confident in change. They had a clear understanding of the current task of their department. However, they only had vague goals and expectations of the change, and employees do not set their individual goals according to the organizational goal, which indicates a weak alignment of organizational goals at the level of employees.

5.5.4. The organizational capability state of company A

It could be concluded that the company's organizational capability is not in a good state to perform the change as the low elevation of organizational perceptual climate is the major problem that might hinder the organizational members from engaging in the change. Apart from that, organizational members do not have enough shared knowledge and skills related to the change. Employees could not estimate the workload during the change, which causes more anxiety and uncertainty for employees. Middle managers are lack of correct understanding of the philosophy of lean and the motivation for the transformation. Their individual goals and goals for the department do not align with the organizational goal. This makes it difficult for middle managers to make transformation goals and plan for themselves and their department. The organizational

goal is not successfully aligned with individual goals that could be solved through communication and support within Company A. The results indicate that the communication is effective between organizational members. Support from supervisors can help organizational members form a positive climate and align the individual goal with the organizational goal. However, both employees and middle managers report little support received from their supervisors. It is challenging for this company to achieve the change with such an OCS.

When a transformational change occurs in an organization, the employees may have a strong feeling of disruption and lose control over their working environment (Rafferty & Jimmieson, 2017). This results in employees' perception of uncertainty caused by anxiety about the job position, job security, and future role within the organization. The perception of uncertainty negatively influences employees' affect and behaviour (Lattuch & Young, 2011; Rafferty & Griffin, 2006). Apart from the scale of change, employees' perception is also influenced by the frequency of change and the involvement in change planning (Lattuch & Young, 2011; Martin-Fernandez et al., 2007; Rafferty & Griffin, 2006). When the frequency of change is high, it is prone to make employees perceive these changes as continuous or constant change and strengthen uncertainty among employees (Rafferty & Griffin, 2006). Employees who involve in change planning report a low anxiety rate during the change ((Lattuch & Young, 2011; Martin-Fernandez et al., 2007)

Various measures are available to shape an OCS beneficial to change. The employees could perceive a massive impact on their work and provoke them to worry about their position in the company during transformational change (Rafferty & Jimmieson, 2017). This concern could arouse the affect of employees and generate stress in such a way that the employees might hold a negative attitude to the change, especially those who have recently experienced a specific type of change (Lattuch & Young, 2011; Lindorff et al., 2011; Rafferty & Jimmieson, 2017). The individual psychological climate could be changed by accepting others' perceptions or generating

new perceptions based on new information. Informal groups existing parallels the formal organizational structure within an organization that organizational members belong to the formal and informal group simultaneously (Kessler, 2019). The profound impact of formal and informal interactions makes it reasonable to consider the influence of co-workers' perception in the measurement of organizational climate (Biancani et al., 2014; G. Chen et al., 2019; Chiocchio & Essiembre, 2009; Hatjidis et al., 2019; O'Leary et al., 2011). An organization should be prepared to help employees cope with the impact, stress, and uncertainty surrounding the working environment during the change. Various factors could influence the organizational climate. Among all these factors, leadership is a vital factor that the supervisor's support and reward are critical factors in shaping the climate of an organization (Maamari & Majdalani, 2017; Zohar & Luria, 2005). The manager's support is proven to be effective in helping employees cope with the change (Martin-Fernandez et al., 2007) that superior support could reduce employees' feelings of uncertainty and stress (Corbett, 2015) and offset the impact from transformational or frequently change (Rafferty & Griffin, 2006). Moreover, sufficient superior support could also raise job satisfaction (Martin-Fernandez et al., 2007). Apart from that, measures such as increasing mental readiness could also improve job satisfaction and performance (Hallett & Hoffman, 2014). At the organizational level, building a consistent and robust change-promoting climate is critical to achieving the organizational goal (Schneider et al., 2013). Making work procedures and organizational policies to encourage employees to engage in the change is an excellent measure to form a positive change climate (Hatjidis et al., 2019). A clear mission plan and good communication could as well improve the willingness to change (Kelly et al., 2017). An organization with more interaction, communication, interdependency, organizational support, and a clear goal is more likely to form a positive climate to change (Schneider et al., 2013).

The modification of OCS requires managers and supervisors to understand how to adaptively organize organizational members. The organizational goal and training are

essential in helping organizational members understand their tasks. For the company in our research, managers should first understand the goal and set up procedures to guide the employees during the change before choosing appropriate employee training. Specific training needs are especially high when employees have high motivation for change but less access to the training resources (Kelly et al., 2017). Stress coping skills should also be included in the training program. Measures such as activation management, cognitive restricting, imagery rehearsal, goal setting, attention control, and routines have proved useful to improve people's performance under stress (Hallett & Hoffman, 2014). The organization should consider providing access to counselling programs or employee assistance programs to help employees deal with stress that could emerge during change (Rafferty & Jimmieson, 2017).

5.6. Feedback

The research team has delivered the analysis of the OCS to the company's management team. They approved that the analysis has revealed their company's real state since they have the same feeling about the company's state described in the analysis according to their daily working experience. The survey has discovered the shared perception as the deeper level construct influencing employees' behaviour. In other words, the survey tells how the employees perceived the change and why they perceived the change in the way shown by the survey results and felt by the managers in working. The management team's confirmation of the survey's quality further approves the reliability and validity of the theory and method used in this research.

Chapter 6. Discussion and future work

This thesis aims to develop a practical approach for the measurement of organizational capability. By practice, it means the method can be used to solve the problem in the real world and the application of the procedures and tools provided by the approach is not limited to a specific case but for the organizations in different kinds of environments. Therefore, two case studies are conducted using two different organizations, both of which exist in the real world. The first case study is a KPI development task for an airline, similar to organizational capability measurement. It demonstrates that two candidate approaches are effective in developing KPI systems that rival the KPI system developed by experts shown in the official documents of the airline. This case study also reveals that the candidate approach A equipt with tools and methodology of EBD is more effective than the approach B only using the methodology of EBD that the performance network in approach A enables the identification of possible results of an action and assists an organization to build dynamic KPI system in quickly changing environment. The second case study combines the questionnaire development method derived from approach A and the OCS model. This combination gives a practical guide to the factors that should be measured for the organizational capability and the procedures to develop an instrument to measure the OCS of an organization. The effectiveness of the questionnaire design approach and the OCS model is demonstrated by measuring the OCS of a manufacturing company through a survey. The results and feedback from the company approve that the approach is capable of illustrating the actual state of an organization in the real world.

The contribution of this research is twofold. Firstly, the OCS model enables the assessment of organizational capability by measuring the state of individuals in an organization. The core logic of this model is to regard an organization as the assembly of organizational members rather than a single entity that the organizational performance is rooted in the individual performance. The success of an organization is achieved by the assembly of individual performance. Thus, the factors influencing the

individual performance and their reflection at the organizational level – organizational knowledge and skills, perceptual and emotional climate, and the goal, become the focus of organizational capability assessment. The OCS model implies that creating an excellent organizational capability state is a bottom-up and top-down process. Individuals create and share knowledge in an organization. Organizational knowledge and skills are the product of bottom-up integrating individual knowledge and skills, while the diffusion of organizational knowledge through training to help individuals gain knowledge is a top-down process. The perceptual and emotional climate is a bottom-up reflection of individual perception and emotion. However, the climate influences individual emotion and perception through a top-down process. The alignment of organizational goals is also a top-down process. The OCS model links individual performance and organizational performance and creates the theoretical foundation for assessing organizational capability through measuring individual factors. The existing methodologies for measuring individual knowledge, skills, perception and affect can be used to assess the OCS by measuring the five primitive factors. Thus, it is practical to implement the OCS model in a real-world organization to assess its organizational capability and estimate its performance.

The second contribution is the EBD-enabled questionnaire design method. The traditional survey guideline is ambiguous and hard to follow for new designers who lack experience in questionnaire construction. The most significant weakness of traditional is the lack of methodology for determining critical factors to be considered in a questionnaire. For designers with little experience in questionnaire design and no access to knowledge of questionnaire design or domain knowledge, and the questionnaire construction becomes an ill-structured problem. The ill-structured problem could cause high stress since individuals' mental resources are limited and lead to poor performance. The EBD-enabled questionnaire design method provides the tools and procedures for non-expert questionnaire designers to collect existing knowledge in a stepwise manner and form new knowledge specific to the task by generating the

network between existing knowledge. Designers' mental resources can be fully used focusing on one problem defined by tools, such as ROM and question asking template, to generate answers effectively using question answering template. With this process moving on from one problem to another, designers can explicate the environment of the questionnaire design problem. By conflict identification, designers can use the information about the task to determine the critical factors that need to be considered in the questionnaire design and turn the ill-defined problem into a well-defined one. The solution generation is achieved using questionnaire design methodology to create questionnaires for measuring the critical factors. The combination of the EBD-enabled questionnaire design method and OCS model produces a less expert-dependent approach, which can be used by organizations with limited resources to conduct effective and cost-efficient organizational capability assessment in changing environments.

The future work will focus on the test of the OCS model and EBD-enabled questionnaire design method in different environments, for example, organizations in the public sector or organizations in other cultural environments. I believe more tests will generate more data for the improvement of the approach to become more efficient and more flexible in practical applications.

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Appendix I. ROM diagrams and answers for Approach A
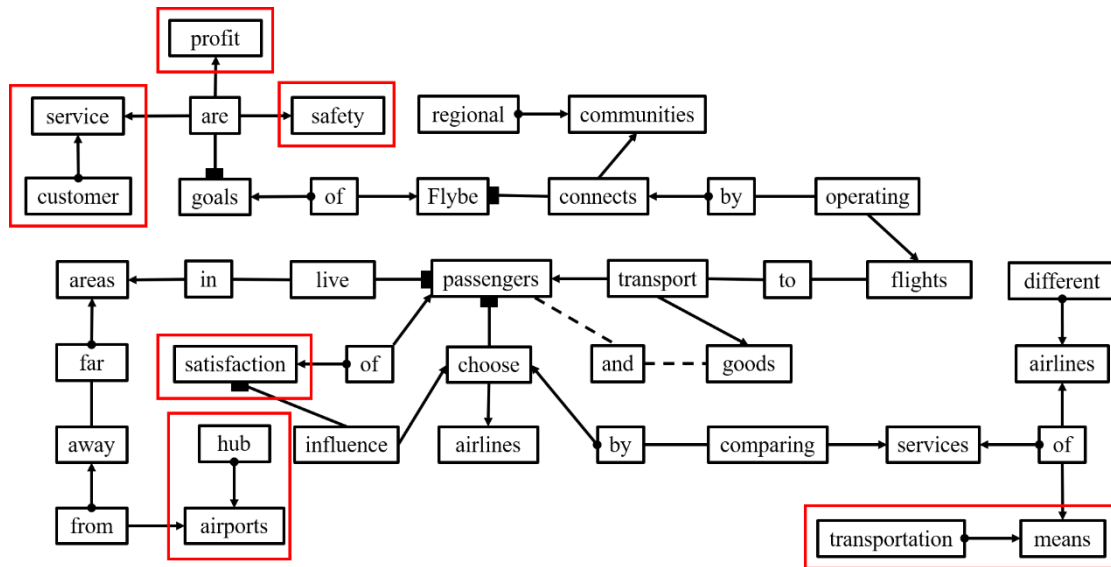
Figure 20: ROM diagram for first-round merged answers No.1

Table 44: Questions for second-round QGA in Approach A

No.	Questions
1.	What makes the profit of Flybe?
2.	What is the lifecycle of an airline's profit?
3.	What is the lifecycle of passenger service?
4.	What influences the passenger service?
5.	What is the lifecycle of an airline's safety performance?
6.	What influences the safety of an airline's safety performance?
7.	What are the criteria of passenger satisfaction?
8.	What is a hub airport?
9.	What are other transportation means?

Table 45: Answers for the second-round QGA in Approach A

No.	Answers
1	• The profit of Flybe is the difference between its revenue and costs.
	• The revenue of Flybe comes from White label service, Flight operation and maintenance, repair, and overhaul service (MRO) (Flybe Annual Report, 2018).
	• Passengers contribute to 89.8% of Flybe's total revenue (Flybe Annual Report, 2018).
	• MRO service and White-label service make up 6.6% and 5.3% of the total revenue, respectively (Flybe Annual Report, 2018).
	• Flybe's costs are related to marketing, airport, staff, ground operation, aircraft rental, charges, fuel, MRO (Flybe Annual Report, 2018).
	• Airport cost, government subsidies, regulations, and competition could influence the cost and revenue (Fageda & Flores-Fillol, 2012; Gillen & Hazledine, 2015).
2	• No information
3	• The service lifecycle involves series of steps, including service for strip planning, ticket purchasing, check-in, boarding, in-flight experience, baggage, and post-flight experience (Bruce et al., 2017).
4	• An airline must properly invest in its unique customer experience strategy.
	• The talent and technology are needed to perform the service (Bruce et al., 2017)
	• The demographic characteristics of passengers can influence their criteria for satisfaction (Castillo-Manzano and López-Valpuesta, 2013).
	• Customer satisfaction is subjective to customer expectation (Rhoades, 2018).
	• Customer expectation is influenced by word of mouth, needs, desire, and past experience (Rhoades, 2018).
5	• No information
6	• Safety management systems, the safety-oriented culture, and good crew training programs are the principal methods to ensure the safety performance of an airline

(Bruce et al., 2017).

7 • The criteria include routes network, safety and punctuality, ticket price, attention and service during the customer journey, other price-related attributes, flight schedule and connections, in-flight space, airline reputation, and previous experience, in-flight catering, and entertainment. Airlines ranked high in characteristics mentioned above are more likely to become the choice of airlines (H.-T. Chen & Chao, 2015; Dennis et al., 2008; Gillen & Hazledine, 2015; Medina-Muñoz et al., 2018; Parrella et al., 2013).

8 • A hub airport is an airport with flights to lots of different places, where people can arrive from one city or country and get flights to other cities or countries (*Hub Airport*, n.d.).

9 • Other transportation means are high-speed trains and highways (Dennis et al., 2008).

Table 46: Merged answers for the second-round QGA in Approach A

No.	Merged answers
1	The profit of Flybe is the difference between its revenue and costs. The revenue of Flybe comes from White label service, Flight operation and maintenance, repair, and overhaul service (MRO), where flight operation contributes most of the revenue by transport passengers. The cost of Flybe comes from the marketing, airport, staff, ground operation, aircraft rental, charges, fuel and MRO. Airport cost, government subsidies, regulations, and competition could influence the cost and revenue.
2	The service lifecycle includes service for trip planning, ticket purchasing, check-in, boarding, in-flight experience, baggage, and post-flight experience. Talent and technology are needed to perform the service. The goal of the service is to improve customer satisfaction. Satisfaction is subjective to the customer expectation, which is influenced by word of mouth, needs, desire, and past experience. The demographic characteristics of passengers can influence their needs and desire. The criteria of

customer expectation include routes network, safety and punctuality, ticket price, attention and service during the customer journey, other price-related attributes, flight schedule and connections, in-flight space, airline reputation, and previous experience in-flight catering, and entertainment.

3   Safety management systems, the safety-oriented culture, and crew training programs are the principal methods to ensure the safety performance of an airline.

4   A hub airport is an airport with flights to lots of different places, at which people can transfer flights.

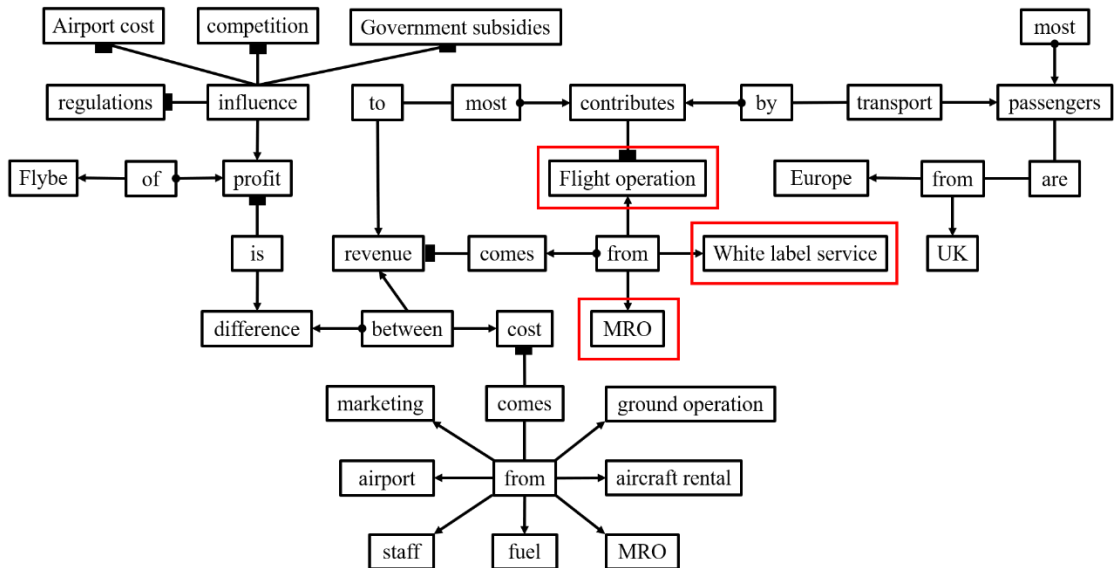5   Other transportation means are high-speed trains and highways

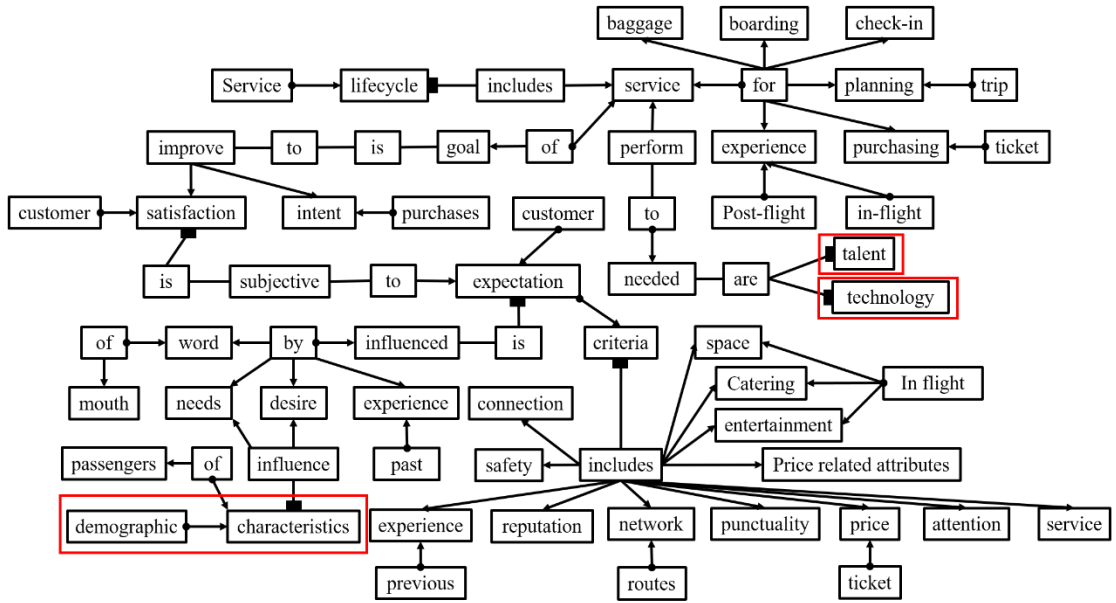Figure 21: ROM diagram for the second-round QGA merged answer No.1

Figure 22: ROM diagram for the second-round QGA merged answer No.2
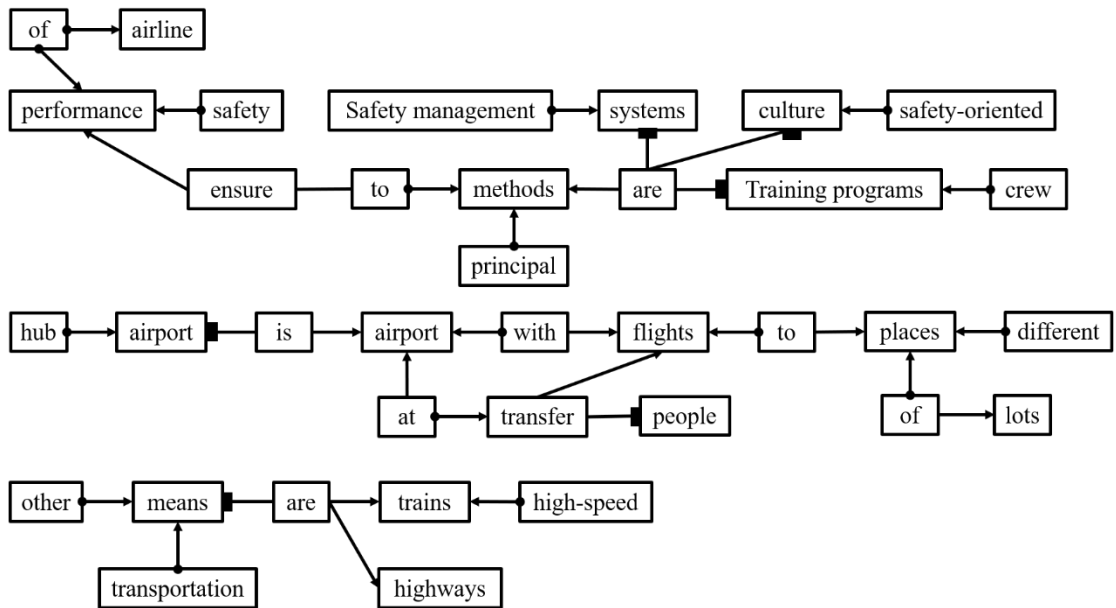
Figure 23: ROM diagram for the second-round QGA merged answer No.3-5

Table 47: Questions for third-round QGA in Approach A

No.	Questions
1.	What is MRO service?
2.	What is the lifecycle of the MRO service?
3.	What influences MRO service?
4.	What is White label service?
5.	What is the lifecycle of White label service?
6.	What influences White label service?
7.	What is flight operation?
8.	What is the lifecycle of flight operation?
9.	What influences the flight operation?
10.	What talent could improve passenger service?
11.	What technology could improve passenger service?
12.	How to improve passenger service?

Table 48: Answers for the third-round QGA in Approach A

No.	Answers
1	• MRO is a broad set of activities to ensure the aircraft remains in a safe condition (Czepiel, 2003). • Flybe's MRO facility focuses on civilian heavy maintenance activity for its fleet and other airlines (Flybe Annual Report, 2018).
2	• No information
3	• New aviation technologies demand new capabilities to perform MRO; thus, outsourcing becomes an alternative to vertical integration (Spafford et al., 2015). • MRO providers usually possess more specialist capabilities and labor force than airlines, ensuring a more professional, efficient, and cost-saving MRO service (Czepiel, 2003; Quinlan et al., 2013; Rodrigues and Lavorato, 2016).

	• Cost and performance, short turnaround time, depth of experience are criteria (Al-kaabi et al., 2007; Michigan, 2009).
4	• Flybe's white-label service is an operating lease that the lessor provides aircraft, crew, MRO, and insurance (Phil, 2014).
5	• No information
6	• Service quality indicated by on-time performance and cancellations are a major concern of legacy airlines (Bourjade, 2017; Dennis et al., 2008; Flybe Annual Report, 2018; K. M. Tan, 2018).
7	• Flight operations are airlines' activities to generate revenue by safely and efficiently moving passengers or cargo (Midkif et al., 2004).
8	• The lifecycle of flight operation involves the following steps: service planning, schedule generation, resource allocation, and flight operation execution (Bazargan, 2010; Grandeau, 1995).
9	• Extensive training and well-established procedures and protocols are essential for a successful flight operation (Midkif et al., 2004). • Fleet influence the operation of an airline (Bourjade, 2017).
10	• Talent required for excellent passenger service is professional skills of the crew, on-time departure and arrival, efficient check-in process, professional skills of office staff, the remedial process for delayed or missing baggage (Alkhatib and Migdadi, 2018).
11	• Passengers need high efficiency of ticketing websites (Llach et al., 2013). • Airlines can use e-commerce tools to know customers and improve airlines' short-term and long-term performance (Llach et al., 2013). • The mobile application is a promising technology for airlines to efficiently connect ticket purchasing and flight service and customize the service (Castillo-Manzano & López-Valpuesta, 2013; Chang & Yang, 2008).
12	• Airlines must identify customers and provide customized service (Rhoades, 2018).

- The measurement of customer satisfaction is necessary at all the touchpoints along airlines' service chains. The assessment of determinants of customer satisfaction is based on the data (Laming and Mason, 2014).

Table 49: Merged answers for the third-round QGA in Approach A

No.	Merged answers
1	MRO is a broad set of activities to ensure the aircraft remains in a safe condition. Flybe is an MRO provider with more specialist capabilities and labour force than airlines, ensuring a more professional, efficient, and cost-saving MRO service. The criteria for an airline's outsourcing of MRO are cost, performance, turnaround time and depth of experience.
2	White-label service is an operating lease. Flybe provides aircraft, crew and MRO for this service. The quality criteria for white-label service are on-time performance and cancellations.
3	Flight operations are activities of airlines to generate revenue by safely and efficiently moving passengers or cargo. The lifecycle of flight operation involves service planning, schedule generation, resource allocation, execution and reallocation. Extensive training and well-established procedures and protocols are essential for a successful flight operation. The fleet could influence the flight operation.
4	Talent for excellent passenger service is professional skills of the crew, on-time departure and arrival, efficient check-in process, professional skills of office staff, the efficient process for delayed or missing baggage.
5	Passengers need an efficient ticketing service. Airlines can use e-commerce tools to know passengers and customize the service. The key is to connect the flight service and ticketing service. The mobile application is a promising technology to connect ticketing service and flight service and improve performance efficiently.
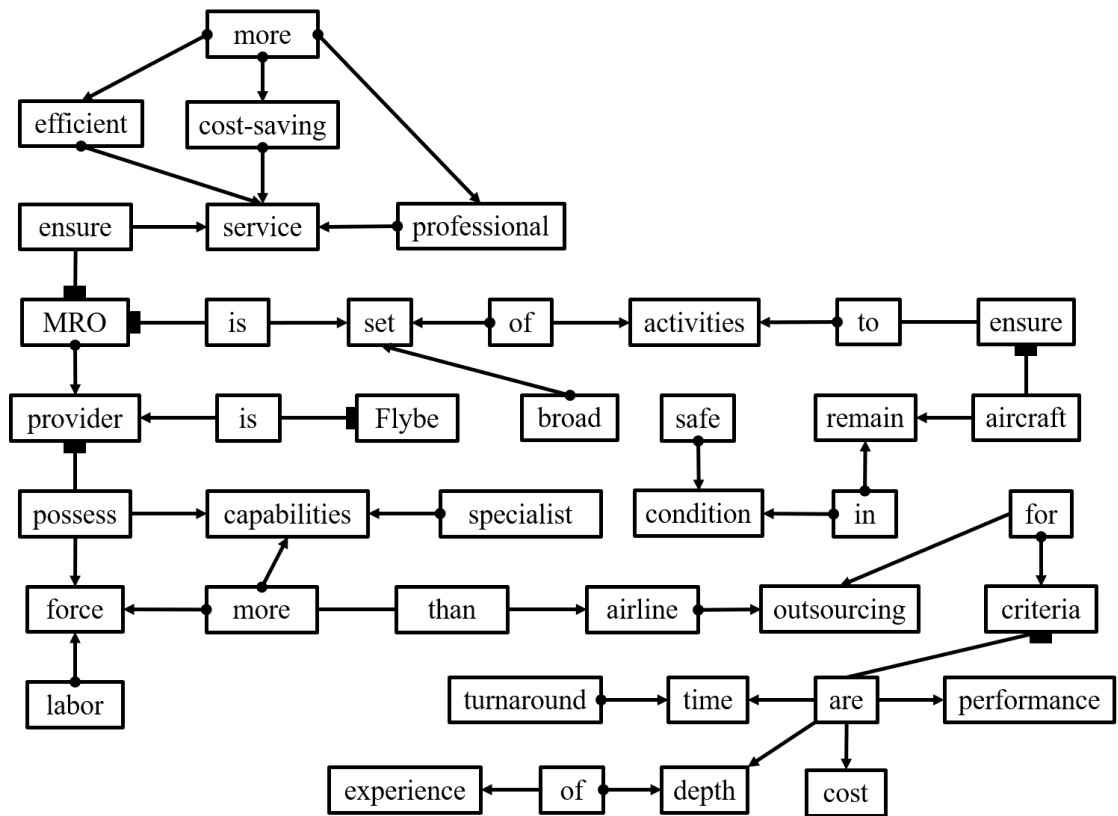
Figure 24: ROM diagram for the third-round QGA merged answer No.1
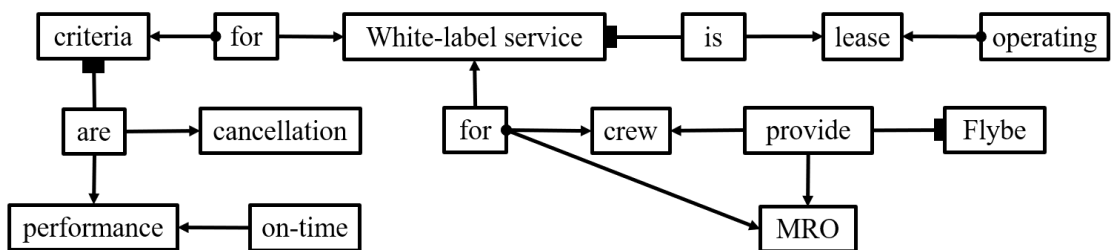
Figure 25: ROM diagram for the third-round QGA merged answer No.2
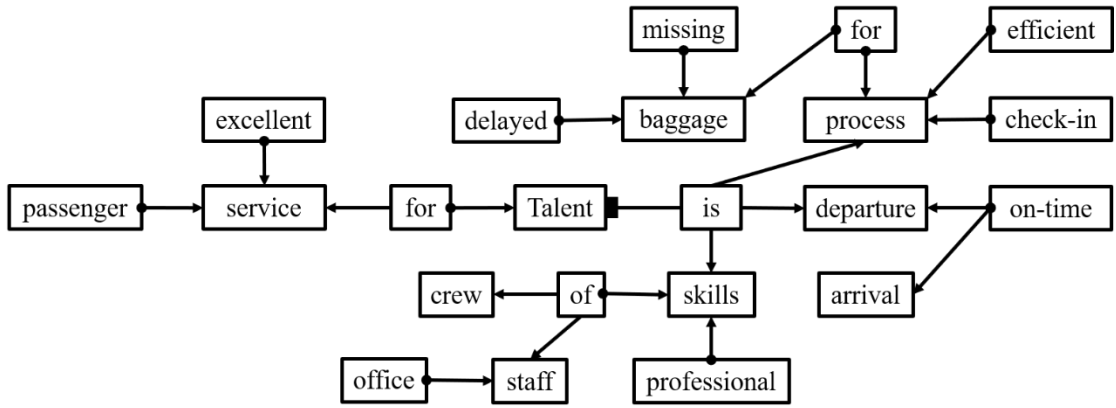
Figure 26: ROM diagram for the third-round QGA merged answer No.3
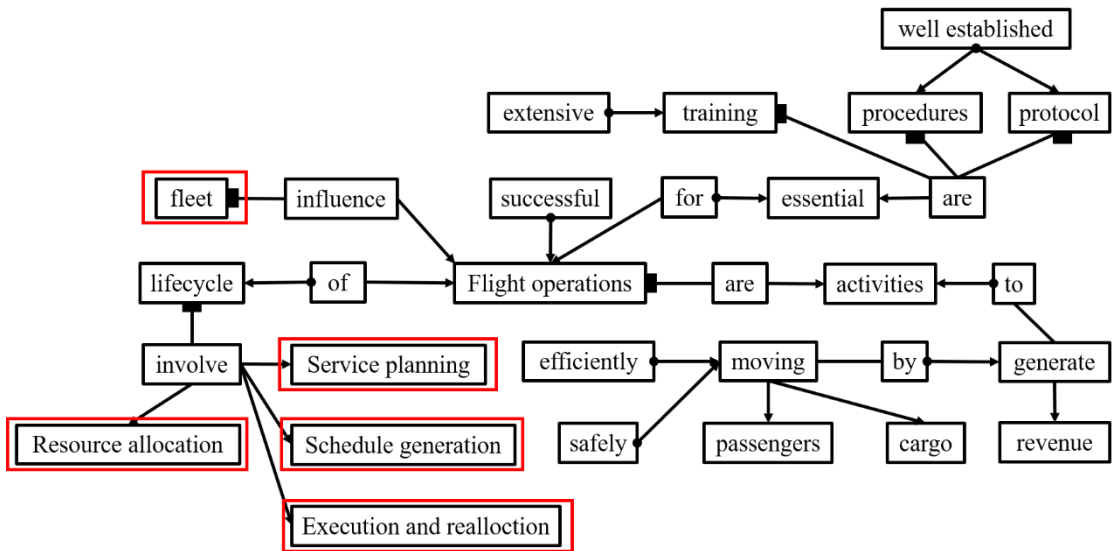
Figure 27: ROM diagram for the third-round QGA merged answer No.4
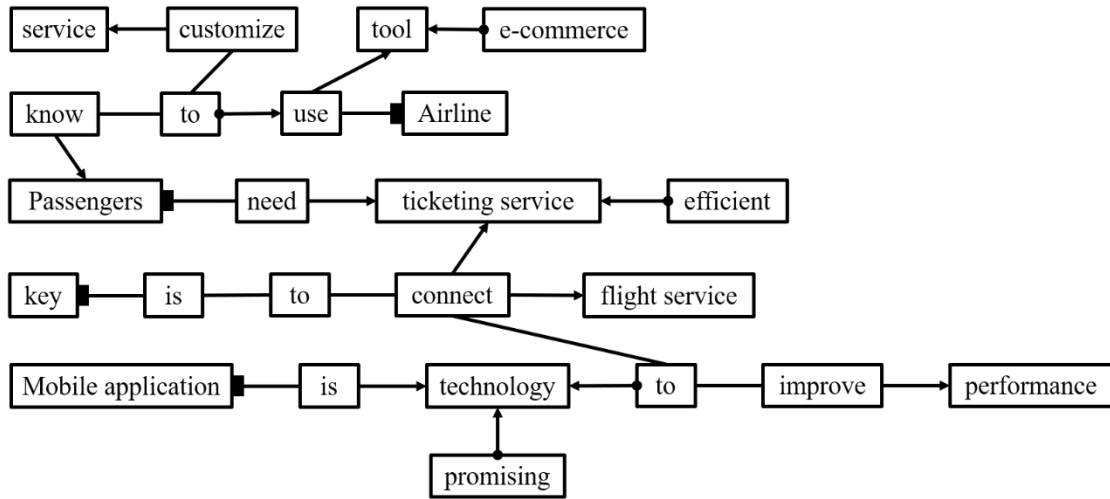
Figure 28: ROM diagram for the third-round QGA merged answer No.5

Table 50: Questions for fourth-round QGA in Approach A

No.	Questions
1.	What is service planning?
2.	What is schedule generation
3.	What is resource allocation?
4.	What are execution and rescheduling?
5.	How does fleet influence flight operation?

Table 51: Answers for the fourth-round QGA in Approach A

No.	Answers
1	The service plan is generated in service planning to change service and add new routes to the network (Bazargan, 2010; Grandeau, 1995). Airline needs to consider multiple factors in creating service, including the marketing initiative, traffic forecasts, expected competition, current schedules, and required resources. Marketing initiative defines the changes in service for entering a new market. Traffic forecasts estimate the total market and the airline's market share (Bazargan, 2010; Grandeau, 1995).

The airline may consider changing the fleet, the size of the crew and the distribution of the crew base (Bazargan, 2010; Grandeau, 1995).

2   Airlines create the passenger schedule, schedule of crew trips, and aircraft schedule in the phase of schedule generation (Bazargan, 2010; Grandeau, 1995).

The fleet size constrains the schedule generation, the number of available crew members, the training of the crew members, the available gates at each airport and the MRO (Bazargan, 2010; Grandeau, 1995).

3   Airlines assign the bidlines to the crew members based on their qualification, certification and seniority of individual crew members (Grandeau, 1995; Medard & Sawhney, 2007; Sohoni et al., 2006).

Airlines also assign aircraft to the appropriate rotations for the new schedule and accomplish gate scheduling in this phase (Grandeau, 1995).

4   Airlines maintain the passenger schedules, crew schedules and schedule of aircraft rotations by executing flights on time (Grandeau, 1995).

Airlines execute rescheduling crew members to respond to irregular operations (Gao et al., 2009; Grandeau, 1995; Medard & Sawhney, 2007; Shebalov & Klabjan, 2006).

5   The size of the fleet and types of aircraft constrains the routes network and schedule of airlines.

Short-haul aircraft fit the regional airlines operating in Europe by saving fuel and cost on the crew (Bourjade, 2017; Dennis et al., 2008; Fageda & Flores-Fillol, 2012).

Table 52: Merged answers for the fourth-round QGA in Approach A

No.	Merged answers
1	Airlines generate service plans in the service planning phase to change service and add new routes to the network. The airline needs to consider multiple factors in service planning, including the marketing initiative, expected competition, current schedules and required resources. Marketing initiative defines the changes in service for a new market. Traffic forecasts estimate the total market and the airline's market share. The

airline may consider changing the fleet, the size of the crew and the distribution of the crew base.

2   Airlines create the passenger schedule, schedule of crew trips, and aircraft schedule in the phase of schedule generation. The fleet size constrains the schedule generation, the number of available crew members, the training of the crew members, the available gates at each airport and the MRO.

3   Airlines assign the bidlines to the crew members based on their qualification, certification and seniority of individual crew members. Airlines also assign rotations to the appropriate aircraft and accomplish gate scheduling in resource allocation.

4   Airlines maintain the passenger schedules, crew schedules and schedule of aircraft rotations by executing flights on time. Airlines execute rescheduling to respond to irregular operations.

5   The fleet size and aircraft type constrain the routes network and schedule of airlines. Short-haul aircraft fit the regional airlines operating in Europe. They save cost on fuel and crew members.

Appendix II. ROM diagrams and answers for Approach B

Table 53: Second-round QGA in Approach B

Questions	Answers
1. What makes the profit of Flybe?	• The profit of Flybe is the difference between its revenue and costs. • The revenue of Flybe comes from White label service, Flight operation and maintenance, repair, and overhaul service (MRO) (*Flybe Annual Report*, 2018). • The UK and Continental Europe are the primary geographic source of Flybe's customers that 83.5% and 15.3% of revenues are contributed to customers from the UK and Continental Europe, respectively. Passengers contribute to 89.8% of Flybe's total revenue (*Flybe Annual Report*, 2018). • MRO service and White-label service make up 6.6% and 5.3% of the total revenue, respectively (*Flybe Annual Report*, 2018). • Flybe's costs are related to marketing, airport, staff, ground operation, aircraft rental, charges, fuel, MRO (*Flybe Annual Report*, 2018). • Airport cost, government subsidies, regulations, and competition could influence the cost and revenue (Fageda & Flores-Fillol, 2012; Gillen & Hazledine, 2015).
2. What is the lifecycle of passenger service?	• The service lifecycle involves series of steps, including service for strip planning, ticket purchasing, check-in, boarding, in-flight experience, baggage, and post-flight experience (Bruce et al., 2017).
3. What influences the passenger	• An airline must properly invest in its unique customer experience strategy.

	service?	•	The organizational readiness and strategy execution through talent and technology could be effective ways (Bruce et al., 2017)
		•	The demographic characteristics of passengers can influence their choice (Castillo-Manzano and López-Valpuesta, 2013).
		•	Customer satisfaction is subjective to customer expectation (Rhoades, 2018).
		•	Customer expectation is influenced by word of mouth, needs, desire, and past experience (Rhoades, 2018).
		•	Satisfaction improves brand recognition; recognition improves purchase intent (Rhoades, 2018).
		•	Cabin layout, seating conditions, inflight entertainment, catering, lounges, and onboard service can change the customers' experience (Parker, 2017).
4.	What is the lifecycle of an airline's safety performance?	•	No information
5.	What influences the safety of an airline's safety performance?	•	The actions related to an airline's safety performance include flying an aircraft, cabin crew operations, dispatch of aircraft or crew, development, design, implementation, and management of the safety-related process in-flight operations, and any other duties prescribed as flight operation safety-related work (Bruce et al., 2017).
		•	Safety management systems, the safety-oriented culture, and good crew training programs are the principal methods to ensure the safety performance of an airline (Bruce et al., 2017).

6. What is the attention and service during the journey?	• Attention and service during the journey include cabin crew attention and service, ground crew (check-in and boarding crew) attention and service, speed of ground services, convenience in making reservations, and buying tickets (Medina-Muñoz et al., 2018).
7. What are the price-related attributes?	• The price-related attributes include the price for checking additional luggage, making changes in the ticket without additional cost, refund if not flying (Medina-Muñoz et al., 2018).
8. What is the other transportation means?	• Other transportation means are high-speed trains and highways (Dennis et al., 2008).

Table 54: Actions and environment components extracted from the second-round QGA in Approach B

Actions	Environment components
1. Flybe creates revenue through White label service, flight operation, and MRO	Flybe, White label service, flight operation, MRO, revenue
2. Passengers contribute the most revenue	Passengers, revenue
3. Most customers come from the UK and continental Europe	Customers, the UK, continental Europe
4. MRO and White-label service make up a small part of total revenue	MRO, White-label service, revenue

5.	Profit related environment components	Marketing, airport, staff, ground operation, aircraft, fuel, MRO, government subsidies, regulations
6.	Airline invests in customer experience strategy	Airline, customer experience, strategy
7.	Airline needs organizational readiness for service	Airline, organizational readiness, service
8.	Airline executes strategy	Airline, strategy
9.	Airline needs talent for service	Airline, talent, service
10.	Airline needs technology for service	Airline, technology, service
11.	Passengers' demographic characteristics influence passengers' choice	Passengers' demographic characteristics, passengers' choice
12.	Customer expectation influence customer satisfaction.	Customer expectation, customer satisfaction
13.	Word of mouth, needs, desire and past experience influence customer expectation	Word of mouth, needs, desire, past experience, customer expectation
14.	Customer satisfaction improves brand recognition, recognition improves purchase intent	Customer satisfaction, brand recognition, customer purchase intent
15.	Customer experience related environment	Cabin layout, conditions of the seating, inflight entertainment, catering, lounges, on-board service, the

	components	customers' experience
16.	Safety-related environment components	Aircraft, cabin crew, safety-related process, flight operation, other safety-related work, safety management system, safety-oriented culture, training.
17.	Attention and service during journey related environment components	Cabin crew, ground crew, speed, convenience, tickets.
18.	Environment components of price-related attributes	Additional luggage, additional costs, refund, changing of tickets
19.	Other transportation means related environment components	High-speed trains, highways

Table 55: Third-round QGA in Approach B

Questions	Answers
1. What is MRO service?	• MRO is a broad set of activities performed by airlines or MRO providers to ensure the aircraft remains in a safe condition (Czepiel, 2003). • Flybe's MRO facility focuses on civilian heavy maintenance activity for its fleet and other airlines (*Flybe Annual Report*, 2018).
2. What is the lifecycle of the MRO service?	• No information
3. What influences MRO service?	• New aviation technologies demand new capabilities to perform MRO; thus, outsourcing becomes an alternative to vertical integration (Spafford et al., 2015). • MRO providers usually possess more specialist capabilities and labour force than airlines, ensuring a

		more professional, efficient, and cost-saving MRO service (Czepiel, 2003; Quinlan et al., 2013; Rodrigues and Lavorato, 2016).
	•	Cost and performance, short turnaround time, range and capabilities, depth of experience, and the ability to assure the highest aircraft utilization are criteria (Al-kaabi et al., 2007; Michigan, 2009).
4. What is White label service?	•	Flybe's white-label service is an operating lease that the lessor provides aircraft, crew, MRO, and insurance (Phil, 2014).
5. What is the lifecycle of White label service?	•	No information
6. What influences White label service?	•	The increasing route competition with low-cost carriers drives European legacy airlines to cut the flight using their own flight and use independent regional airlines to replace their position on the short routes (Bourjade, 2017; Dennis et al., 2008)
	•	Service quality indicated by on-time performance and cancellations are a major concern of legacy airlines (Bourjade, 2017; Dennis et al., 2008; Flybe Annual Report, 2018; Tan, 2018)
7. What is flight operation?	•	Flight operations are airlines' activities to generate revenue by safely and efficiently moving passengers or cargo (Midkif et al., 2004).
8. What is the lifecycle of flight operation?	•	The lifecycle of flight operation involves the following steps: flight schedules, fleet assignment, aircraft routing, crew scheduling, resource allocation, and flight operation execution (Bazargan, 2010).

9. What influences the flight operation?	• A successful operation is achieved by the smooth cooperation of many responsible parties, including flight crews, dispatch, maintenance, ticketing/gate agents, guide/push crews, baggage handlers, caterers, and fuelers (Midkif et al., 2004).
	• Extensive training and well-established procedures and protocols are essential for a successful flight operation (Midkif et al., 2004).
	• Fleet influence the strategy of an airline (Bourjade, 2017).
	• Short-haul aircraft fits the regional airlines operating in Europe by saving fuel and cost on the crew (Bourjade, 2017; CAPA, 2014; CAPA, 2015; Dennis et al., 2008; Fageda and Flores-Fillol, 2012).
	• Crew scheduling covers the complete flight schedules with minimum crews and assigns training schedules to eligible crews (Medard and Sawhney, 2007; Sohoni et al., 2006).
	• Airlines manage disruptions by rescheduling crews (Gao et al., 2009; Medard and Sawhney, 2007; Shebalov and Klabjan, 2006; Sohoni et al., 2006).
	• The Airline Operation Control Center coordinates the resources and personnel required for the flight operations (Clarke and Naryadi, 1995; Grandeau, 1995)
	• The operation of the airline operation control center is supported by the Maintenance Operations Control Center and various Ground Operations Control Centers (Clarke and Naryadi, 1995; Grandeau, 1995).

	• Ground operation is the airline's action dealing with the passengers and cargo mail involving passenger and baggage handling, baggage preparation for loading, ground support equipment, pushback and headset, deicing, staff training, etc (Dück et al., 2012).
	• The core of the ground operation is the airport turnaround process (Dück et al., 2012).
	• Most airline-related delays can be attributed to activities in the turnaround process (Dück et al., 2012; Ground Operations, 2021; Wu, 2008).
	• The primary delay causes are divided into the airline, airport, en-route, governmental, weather, miscellaneous, and reactionary (Walker, 2018).
10. What influence Flybe service between the UK and EU	• Brexit is an event that might significantly impact the airlines operating flights connecting Continental Europe with the UK, especially the UK-based airlines (Giles, 2016).
	• Airports in the EU are essential transfer stations for UK passengers that around one-quarter of passengers departing from EU airports flying to third destinations are from the UK (Giles, 2016).
	• Airlines based in the UK would lose access to the EU and be forced to face new UK regulations if no agreement is reached before the expiration of EU treaties (Duhaneanu, 2017; A. Tan, 2016).
	• Regulation changing would influence the tax and tariffs to be paid by airlines and impact the customer-airline relationship with new delay regulations (Duhaneanu,

	2017; Giles, 2016; Stamp, 2016; Tan, 2016)..
	• The future of the aviation market between the UK and EU will remain uncertain until an agreement is reached, and the process is expected to be slow (Giles, 2016).
	• Airlines need to assess the impact of the possible result of Brexit negotiation and take strategic decisions to choose the best course for them (Stamp, 2016; A. Tan, 2016).
11. What talent could improve passenger service?	• Talent required for excellent passenger service is professional skills of the crew, on-time departure and arrival, efficient check-in process, professional skills of office staff, the remedial process for delayed or missing baggage (Alkhatib and Migdadi, 2018).
12. What technology could improve passenger service?	• Passengers need high efficiency of ticketing websites (Llach et al., 2013).
	• Airlines can use e-commerce tools to know customers and improve airlines' short-term and long-term performance (Llach et al., 2013).
	• The mobile application is a promising technology for airlines to efficiently connect ticket purchasing and flight service and customize the service (Castillo-Manzano and López-Valpuesta, 2013).
13. How to improve passenger service?	• Airlines must identify customers and provide customized service (Rhoades, 2018).
	• The measurement of customer satisfaction is necessary at all the touchpoints along airlines' service chains. The assessment of determinants of customer satisfaction is based on the data (Laming and Mason, 2014).

Table 56: Actions and environment components extracted from the third-round QGA in Approach B

Actions	Environment components
1. MRO service ensures the safety of aircraft	MRO service, safety, aircraft
2. Flybe provides MRO service for its own fleet	MRO service, Flybe, fleet
3. Flybe provides MRO for other airlines	MRO service, Flybe, other airlines
4. New aviation technologies demand new MRO capabilities	Aviation, technology, MRO capability
5. Airlines outsource MRO	Airlines, MRO
6. MRO providers possess specialist capabilities and labour force	MRO, specialist capabilities, labour force
7. Outsourcing ensures professional, efficient, and cost-saving MRO service	Professional MRO, efficient MRO, cost-saving MRO
8. Environment components of MRO criteria	Cost, performance, short turnaround time, capabilities, experience, high aircraft utilization
9. Flybe provides aircraft, crew, MRO and insurance for White label service	aircraft, crew, MRO, insurance, White label service
10. European legacy airlines compete with low-cost carriers	European legacy airlines, low-cost carriers

11. European legacy airlines use regional airlines on short-haul routes	European legacy airlines, regional airlines, short-haul routes
12. Environment components of legacy airlines' concern	Service quality, on-time performance, cancellations
13. Flight operation related environment components	Revenue, safety, efficiency, passengers, cargo, flight, fleet, crew, resource, maintenance, ticketing agents, guide/push crew, baggage handlers, caterers, fuelers, training, procedures, protocols
14. Fleet influence the strategy of an airline	Fleet, strategy, airline
15. Short-haul aircraft fits regional airlines operating in Europe	Short-haul aircraft, regional airline, Europe
16. Short-haul aircraft save fuel	Short-haul aircraft, fuel
17. Short-haul aircraft save cost	Short-haul aircraft, cost
18. Crew scheduling covers the flight schedules with minimum crews	Crew scheduling, flight schedules
19. Crew scheduling assigns training schedules to eligible crews	Crew scheduling, training, crews
20. Airline manage disruptions	Airline, disruptions
21. Airline reschedule crews	Airline crews
22. Airline operation control center allocates resources and personnel	Airline operation control center, resources, personnel
23. Maintenance operation control center supports operational	Maintenance operation control center, operational control center

control center

24.	Ground operation center supports operational control center	Ground operation center, operational control center
25.	Ground operation deal with passengers, baggage and ground operation.	Ground operation center, passengers, baggage, ground operation
26.	Most airline-related delays happen in the turnaround process	Airline-related delay, turnaround process
27.	Delay related environment components	Airline-related delay, airport-related delay, en-route delay, governmental delay, weather, miscellaneous and reactionary delay
28.	Brexit impacts airlines connecting the UK and the EU	Brexit, UK, EU, airlines
29.	UK passengers transfer at EU airports	UK passengers, EU airports
30.	Airlines based in the UK would lose access to EU	Airlines, UK, EU
31.	Airlines based in the UK would face new UK regulations	Airlines, UK, regulations
32.	New regulations influence profit	Regulation, profit
33.	New regulations influence customers	Regulation, customer
34.	Airlines need to assess possible Brexit impact	Airlines, Brexit impact
35.	Airlines need to choose a strategy	Airlines, strategy

36. Talent related environment components	Skills, crew, on-time performance, check-in process, office staff, remedial process, baggage.
37. Passengers need high efficiency of ticketing websites	Passengers, high efficiency, ticketing website
38. Airlines can use e-commerce tool	Airlines, e-commerce tool
39. Airlines know customers	Airlines, customers
40. Airlines improve short-term and long-term performance	Airlines, long-term performance, short-term performance
41. The mobile application connects ticket purchasing and flight service	Mobile application, ticket purchasing service, flight service
42. The mobile application customize service	Mobile application, service
43. Airlines identify customers	Airlines, customers
44. Airlines provide customized service	Airlines, service
45. Airlines measure customer satisfaction at touchpoints along the airline's service chain	Airlines, customer satisfaction, touchpoints, service chain
46. Airlines connect the flight service and ticketing service	Airlines, flight service, ticketing service

Table 57: The list of environment components after categorization in Approach B

Natural	Human	Built
1. Fuel 2. Weather	3. Passengers (Passengers' demographic characteristics, UK passengers, Customer expectation (Word of mouth, needs, desire, past experience) Customer satisfaction (punctuality, ticket price, attention, services during journey, other price-related attributes, flight schedule, flight connection, in-flight space, airline reputation, previous experience, in-flight catering, in-flight entertainment) Customer experience, Passengers' choice (customer purchase intent) 4. Staff (Cabin crew (Crew scheduling), ground crew (ticketing agents, guide/push crew, baggage handlers, caterers, fuelers, office staff)	5. Goods 6. Safety 7. Profit (revenue, cost) 8. Service (cabin layout, conditions of the seating, inflight entertainment, catering, lounges, on-board service, additional luggage, additional costs, refund, changing of tickets, service quality, on-time performance, cancellations, ticket purchasing service, flight service, touchpoints, service chain, flight service, ticketing service) 9. Flybe (regional airlines, airlines) 10. Regional airports (Regional communities, Regional areas) 11. Flight (flight operation (flight schedules, Crew scheduling), Airline operation control center) 12. Hub airports (EU airports) 13. Other airlines (European legacy airlines, low-cost carriers) 14. Other transportation means (high speed train, high way) 15. MRO (Professional MRO, efficient MRO, cost-saving MRO, Cost,

performance, short turnaround time, capabilities, experience, high aircraft utilization)

16. White label service

17. UK

18. EU (Continental Europe, Europe)

19. Ground operation (Ground operation center, baggage, turnaround process)

20. Regulations (Government subsidies)

21. Strategy (Route network, Marketing)

22. Organizational readiness

23. Talent (Skills)

24. Technology (e-commerce tool, Mobile application, ticket, Ticketing website (High efficiency))

25. Brand recognition

26. Fleet (Aircraft (Short-haul aircraft))

27. Resource

28. Procedures (remedial process, protocols)

29. Training

30. Disruptions

31. Delay (Airline-related delay, airport-related delay, en-route delay, governmental delay, weather, miscellaneous and reactionary delay)

32. Brexit (Brexit impact)

Appendix III Questionnaire

Appendix III. Questionnaire for OCS assessment of Company A

Table 58: Questionnaire for the top manager

No	Questions	Your answer				
	Please select one response for each item	Scaling				
	1=Strongly agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree	1	2	3	4	5
1	Transformation is necessary for Product Development. Why? _____					
2	Your subordinates are confident toward the transformation.					
3	Your subordinates have a fair workload.					
4	Your subordinates are willing to change your organization into a Lean enterprise (continuous improvement mindset).					
5	You are fairly recognized compared to the average market level.					
6	Your subordinates satisfied with their current status.					
7	The upcoming transformation will add more workload on you.					
8	You are satisfied with current status.					

	Please put the letter of all the responses that apply to the question in the blank space (if you have other answers please specify)						
9	9.1 What are the necessary prerequisites for the lean change in your opinion? (Please select all that apply)						
	9.2 Among them, which are ready?						
	A	B	C	D	E	F	G
	Understanding the goals of lean change for everyone	Recruit lean experts	Willingness to change of all the organization	Consultation from specialists in lean change management field	Lean transformation tools	Lean culture	Others _____
	Please answer following questions with your own words in the blank space						
10	What do you think of the organization's structure in current state?						
11	Do you think the subordinates have enough knowledge and skills in implementing transformation?						
12	Please describe the challenges/risks in the transformation.						
13	What kind of benefits can be brought by the transformation?						
14	What are your main work responsibilities? Please rank your responsibilities by priority?						
15	What are the main work responsibilities of your direct subordinates? Please rank their work responsibilities by priority?						
16	What is the current goal of Production Development?						
17	What is your expectation after the transformation?						

18	To achieve this goal, what resources do you need to support you?	
19	What kind of current problems can be solved by the transformation?	
20	Which aspects of your organization do you expect to change in the transformation? Please rank these aspects by priority?	

Table 59: Questionnaire for middle managers

No	Questions	Your answer				
	Please select one response for each item	Scaling				
	1=Strongly agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree	1	2	3	4	5
1	Transformation is necessary for Product Development. Why? _____					
2	Your subordinates are confident towards the transformation.					
3	Your subordinates have a fair workload.					
4	You are confident towards the transformation.					
5	Your subordinates are willing to change your organization into a Lean enterprise.					
6	You are fairly recognized compared to the average market level.					
7	You are willing to change your organization into a Lean enterprise.					
8	Your direct subordinates could perceive goals correctly as you expect.					

9	Your subordinates are satisfied with their current status.					
10	The upcoming transformation will add more workload on you.					
11	You are satisfied with current status.					

12	Are there any opportunities for promotion within your organization?	Yes, fair	Yes, but rare	No chance

13	13.1 Do your subordinates have enough knowledge and skills in implementing transformation?	Yes.	Not sure.	No, they need more
	13.2 Do they need training related with lean change?	Yes.	No, they can manage themselves.	No, no resources for training.
	13.3 If yes, which kind of training should be provided?	Knowledge about lean (continuous improvement).	Knowledge related with their own job after transformation.	Others_____

Please put the letter of all the responses that apply to the question in the blank space (if you have other answers please specify)

14	14.1 What are the necessary prerequisites for the lean change in your opinion? (Please select all that apply)					
	14.2 Among them, which are ready?					
	A	B	C	D	E	F	G
	Understanding the goals of lean change for everyone	Recruit lean experts	Willingness to change of all the organization	Consultation from specialists in lean change management field	Lean transformation tools	Lean culture	Others _____

15	Which skills and competencies are necessary for you to achieve the goal of your department?						
	A	B	C	D			
	Professional designation	Working experience	Leadership (Communication)	Project management skill			
16	What are your expectations for your department to undergo transformation?						
	A	B	C	D			
	Increase productivity	Lower operating cost	Higher employee morale	Others_____			

	Please answer following questions with your own words in the blank space	
17	Please describe the challenges/risks in the transformation.	
18	What kind of benefits can be brought by the transformation?	
19	What are your main work responsibilities? Please rank your responsibilities by priority.	
20	What kind of support have you received from your superior for the coming transformation so far?	
21	What is the current goal of your department?	
22	What are the main work responsibilities of your direct subordinates? Please rank their work responsibilities by priority.	
23	23.1 What is your expectation after the transformation?	
	23.2 What do you need to do to achieve this expectation?	

No	Questions						
	23.3 What kind of resources are needed to achieve this expectation?						
24	What kind of current problems can be solved by the transformation?						

Table 60: Questionnaire for employees

No	Questions		Your answer				
Please select one response for each item			Scaling				
1=Strongly agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree			1	2	3	4	5
1	You are willing to change to the use of a lean working process.						
2	You are confident towards the transformation.						
3	Your colleagues are confident towards the transformation.						
4	Your colleagues are willing to change to the use of a lean working process.						
5	You are fairly recognized compared to the average market level.						
6	Your colleagues are satisfied with their current status?						
7	You are satisfied with your current status?						
8	After the transformation initiative, what impact will it have on your daily work?	Increase workload	No change	Reduce workload	No idea		

9	Are there any opportunities for promotion within your organization? How is the chance?	Yes, fair.	Yes, but rare.	No chance.	Comments: _____
10	Do you need training for the transformation? What do you need?	Yes, training related to transformation should be offered.	No, the existing training can meet my needs for my current work.	If you choose A, please specify:	
11	Have you received any support for the transformation so far?	Yes. Please specify: ____		No. What do you expect? ____	

Please put the letter of all the responses that apply to the question in the blank space (if you have other answers please specify)

	What knowledge or skill do you have to achieve your goal?								
	A	B	C	D	E	F	G	H	I
12	Relevant experience and qualification	Good problem-solving skills	Excellent negotiating /influencing skills	Strong analytical skills	Emotion management skill	Language (both spoken and written French and English)	Team player	Creativity	Project management skill

Please answer following questions with your own words in the blank space

13	What is the current objective of your work?	

14	What is your expectation after the transformation?	