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# PROJECT TIME, COST AND QUALITY CONSTRAINTS MANAGEMENT THROUGH STRUCTURED FUZZY MAPPING ON PSYCHOLOGICAL PHENOMENA

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**Abstract.** Construction business involves people from different employers who have to work together in one project, thus a project manager needs to apply scientific principles to understand and to utilize those common psychological phenomena such as Hedgehog Effect, Butterfly Effect, Pygmalion Effect, Boiled Frog Syndrome, Parkinson's Law, and Bandwagon Effect in completing work well and keeping people satisfied. The aim of this study is to develop a fuzzy mapping to assist project managers in implementing significant psychological phenomena in construction management through reflections on common psychological phenomena in the construction management. Through a structured interview survey among construction managers, the inferential association among gender, working experience, and the six psychological phenomena were plotted based on the Partial Least Square Structural Equation Modelling. Through the pairwise comparison technique, a fuzzy mapping of psychological phenomena in time, cost, and quality management was developed to facilitate the managerial efficiency in construction.

**Keywords:** psychological phenomena, behavior simulation, decision making, Fuzzy Logic, project triple constraints.

## Introduction

Construction business involves people from different organizations, with often very different personality and backgrounds, that come together to achieve a common objective. The project-based nature and complexity of construction industry have made it as one of the most challenging environments for project manager to work with (Loosemore et al., 2003). Thus, there is a need to apply scientific principles to utilize common psychological phenomena to help complete work and keeping people satisfied (Doh et al., 2017; Kun, 2020). As suggested by Milajerdi et al. (2019) and Lee (1999), an effective training for managers should include awareness of common psychological phenomena that are seen in project management, including: Hedgehog Effect, Butterfly Effect, Pygmalion Effect, Boiled Frog Syndrome, Parkinson's Law, and Bandwagon Effect. However, there is still some confusion and lack of knowledge in understanding how these psychological phenomena impact the personnel within construction industry and whether they can be used to facilitate the managerial efficiency in construction in terms of time, cost, and quality management. Therefore, more research is needed on how such psychological effects play a role in construction management. It is important and useful for managers to be able to predict the behaviors of team members (Bitterl & Schreier, 2018; Wang et al., 2016) as it is a range of staff that could either block or facilitate the progress towards specified project goals (Rao et al., 2019; Agarwal et al., 2021). Management psychology is about how to effectively manage an organization while taking into account the psychological impact on the organization and all stakeholders (Xia et al., 2022). By applying managerial psychology in management processes,

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managers will be able to exert greater control over the work environment (Krausert, 2017), make the best use of human resources (Hall, 2016), and avoid dissatisfaction among the team members (Zulch, 2014), and make sure the entire team collaborate, share, integrate information to achieve the project objectives (Carmeli et al., 2021). Managerial psychology is a diverse scientific discipline with many applications in daily life (Hribar et al., 2017). The main concern of psychology understands what makes people behave as they do (Gu et al., 2019); thus, it necessarily draws on knowledge about learning, emotions, intelligence, and differences between humans, development of personality, and the power of group influences (Kubiak, 2022). A project manager must lead, manage, synchronize, and coordinate all personnel involved in a project and this process can be made easier by the application of psychological principles (Zhang, 2021; Sözüer & Spang, 2014). Through empirical data based on managerial reflection on the occurrence and use of these common Psychological Phenomena in construction management, the aim of this study is to develop a fuzzy mapping that can assist project managers to understand the relative importance of these phenomena in their industry, allowing them to better apply these principles in the future.

## 1. Psychological phenomena

Psychology has a broad coverage. Applied psychology generally can be divided into three branches. Clinical psychology focuses on issues related to the diagnosis and treatment of mental illness. Educational psychology, on the other hand, concentrates on educational-related issues such as educational potential, personal issues, school life, and the technology used in education. The third branch is occupational psychology, which is the main scope of this research. It is related to an area of work that psychologists focus on, namely increasing job satisfaction and efficiency (Ribeaux & Poppleton, 1978). Occupational psychology is the application of psychological knowledge in the working environment (Ribeaux & Poppleton, 1978), and it is used interchangeably with other terms including "industrial psychology", "organizational psychology", and "occupational psychology" (Starchenkova, 2020). The concept focuses on both the leadership and organizational structure where people are brought together as one to complete tasks and achieve the set goals (Furnham, 2007). Psychological research on organizational behaviors mainly consists of four interrelated aspects: morale and employee productivity; satisfaction and motivation; leadership and supervision; and organizational development. Many psychological research has implied that there is a relationship between certain psychological phenomena and management efficiency. For example, failing to recognize the significance of Hedgehog Effect may result in poor team performance because people fail to maintain a suitable and effective working distance between team members (De Vries, 2011), Pygmalion Effect has been identified as a crucial foundation for effective leadership processes as it enables leaders to understand how to motivate the subordinates by moderating and expressing their own expectations (White & Locke, 1968), Bandwagon Effect can influence the quality of decision-making in the organization (Fiol & O'Connor, 2003). Furthermore, Parkinson's Law has a significant application in time management (Pannett et al., 2013). Despite the fact that many research in management science have focused on various psychological phenomena, little research has been conducted in the field of construction industry. As such, six psychological phenomena have been selected for the purpose of study as they are common to construction management and happen frequently in the construction industry. The selected phenomena are: Hedgehog Effect, Butterfly Effect, Pygmalion Effect, Boiled Frog Syndrome, Parkinson's Law and Bandwagon Effect. Understanding the impact of such phenomena on construction project participants can help project manager better arrange appropriate staff for projects at different stages, maintain good teamwork and enhance effective project management in the construction industry.

### 1.1. Hedgehog Effect

Hedgehog Effect, or Porcupine Dilemma, was introduced by Arthur Schopenhauer in his essay "Parerga and Paralipomena" in 1851; according to Schopenhauer (2012), to some extent human behavior reflects these attributes. During winter, hedgehogs were drawn together in order to benefit from the warmth from other hedgehog to avoid themselves from being frozen to death. However, due to the closeness, they were hurt by the spines of the others, forcing them to move away to become more comfortable. Yet, the further away they moved, the more they needed warmth, causing them to shuffle closer again, despite the possibility of again being hurt (Schopenhauer, 2012). The hedgehogs would then keep moving forwards and backwards until they discovered a suitable distance where they benefited from the warmth of others while avoiding injuries by not being too close (Schopenhauer, 2012).

### 1.2. Hedgehog Effect in organizations

Few people can tolerate an overly intimate relationship with their colleagues (Schopenhauer, 2012); yet, the successful team-based cooperation requires simultaneous closeness and maintenance of distance (De Vries, 2011) – in other words, team activities require managers to understand the Hedgehog Effect. For individuals, however, it is usually challenging to determine the most appropriate distance between themselves and colleagues (Frosh, 2003). Commonly, in many long term relationships between two people, any initial hostility felt to the other will not be exposed but instead repressed (Freud, 1949). The Hedgehog Effect therefore stresses on the challenges associated with human intimacy and understanding the effect can therefore be supportive of building high perfor-

mance teams. Many executive teams are ineffective due to the difficulty in maintaining the developed trust within the group (Meng, 2012). Over- and under-trusting both have negative implications (Frosh, 2003). In addition, different personalities portrayed by the team members may cause relationship conflicts that would lead to the failure of achieving the designated goals. Leaders should, therefore, appreciate the complexity of teamwork and have a particular focus on investing sufficient attention to the existing of hedgehogs' dilemma in the organization (De Vries, 2011). In short, a competent leader should not only concern about the management structure or process but he or she should pay more attention on the team dynamics and getting more familiar with the language of psychodynamic with the objective to enforce the values of trust, cooperation, enthusiasm and enjoyment in the organization (De Vries, 2011).

### 1.3. Butterfly Effect

Edward Lorenz was a mathematician and meteorologist who famously discussed how "the flap of a butterfly's wings in Brazil set off a tornado in Texas". The implication is that a tiny action can lead to significant differences in outcomes, or that a small change in the initial conditions in a system can led to large differences in outcomes (Kincanon & Powel, 1995). This psychological effect originated in 1960s when Lorenz developed a simple computer model, hoping that it could help in more accurate weather prediction (Kincanon & Powel, 1995). Based on initial temperature, pressure, and wind speed data the software was supposed to calculate how the parameters would change, based on established models. Lorenz was surprised as the result in his second run was substantially different from the first run – even though he had used the same data. However, the team eventually realized that the differences in the observed outcomes were due to the very slight differences between what was on the printout and the values in the computer memory which were being used in the model. Lorenz initially commented on this phenomenon as "one flap of a seagull's wings could change the course of weather forever" but he then changed the metaphor to "butterfly" (Kincanon & Powel, 1995).

### 1.4. Butterfly Effect in management

The Butterfly Effect reflects the sensitivity to initial conditions, where a tiny or unnoticeable change in a dynamic system at the beginning may lead to a very large difference in outcomes over time (Lee, 1999). This psychological effect brings up an important idea which is the relationship between the ability and performance of a particular person may not obvious at the initial stage but once a specific timing is reached, the effect of small incremental increase in the person's behavior will have a great potential in producing a significant improvement in the effectiveness (Boyatzis, 2006). Therefore, no single party should be neglected. This can explain a range of unexpected outcomes such as sudden outbreaks of riots, a run on a bank, or a drop in the value of the stock market (Boyatzis, 2006). Many things in human lives are the small components of larger systems, where all components are interconnected and eventually influence each other. System thinking emphasizes understanding how things affect and influence each other within a system. In the context of an organization, a system consists of not only people but also the information and processes that work together which aid in determining organization healthy. In organizations, all decisions made by the executives will have some impact, whether positive or negative, on the person involved or even the whole organization. Consequently, every decision made within the organization must be given proper consideration because any small decision may affect other people greatly. Some organizations may face the crisis due to a tiny wrong decision made at the critical moment. While a leader is critical in initiating actions, the words used or the priorities set may trigger a Butterfly Effect in the lives of all the participants, client, staff, or colleagues (Hills et al., 2008). As a result, it is critical that good leadership and skill in management are not overlooked, as a less competent leader or manager may have negative consequences for the organization in the short and long term simply by making the wrong key decision (Hill, 2013).

### 1.5. Pygmalion Effect

The Pygmalion Effect is derived from the Greek mythology (Reynolds, 2000) surrounding Pygmalion, a prince of Cyprus who preferred to remain alone and instead of enjoying the company of women sculpted an ivory statue of his ideal woman. The sculpture was so perfect that Pygmalion fell in love with it; a love so deep that it touched the goddess Aphrodite, who granted life to the sculpture, who then lived with Pygmalion. More recently, a 1913 play, "Pygmalion", was introduced by George Bernard Shawn based on the theme that "one person can transform another person by projecting expectations" (Salkind, 2010). The Pygmalion Effect is also known as "Rosenthal Effect", "self-fulfilling prophecy" or "expectancy effect" (Salkind, 2010). Similarly, the term "self-fulfilling prophecy" is often used in sociology and psychology, which demonstrates the importance of positive feedback between belief and behavior (Stoicescu & Ghinea, 2013).

### 1.6. Pygmalion Effect in education

Pygmalion Effect is a psychological effect which was first studied by Robert Rosenthal in the field of education in 1960s and he then cooperated with Lenore Jacobson to carry out research in educational institution. The earliest application of the Pygmalion Effect was in the educational sector (Salkind, 2010) in the year 1968, conveying the message that pupils' intelligence could be raised by increasing teachers' expectations of the pupils (Spitz, 1999). In their research, they established that if teachers were told that tests indicate that certain students (who are actually

chosen randomly) have a great potential to perform well in the future, most of these students will really grow intellectually and achieve the expectation (White & Locke, 1968). The teachers, responding to these data, then treated the students in a different way through the use of facial expressions, postures, and even touch, in ways that they would not have done if they did not believe the students to be exceptional (Brodersen, 2001). The attitude of teacher and possible changes in the teaching techniques had significant impact on the students, who were then more motivated on their own behaviors, which led improved academic performance in the experiment (Brodersen, 2001).

### 1.7. Pygmalion Effect in management

Many researchers emphasized the workplace settings and processes to determine how the subordinate performance can be improved through the use of positive compliments or changed supervisory expectations (Reynolds, 2000). In the managerial context, Pygmalion Effect is related to leaders' expectations towards the subordinate performance as this may have a subconscious effect on the leaders' behavior as well as the subordinate performance (White & Locke, 1968). In practical applications, the Pygmalion Effect has been identified as a crucial foundation for effective leadership processes as it enables leaders to understand how to motivate the subordinates through moderating and expressing their own expectations (White & Locke, 1968). However, there can also be unintended effects, or a negative Pygmalion Effect which is also known as Golem effects; here, there are undesirable changes in subordinates' performance due to the supervisor's expressed negative expectations (Reynolds, 2000). The low expectations and damaged egos cause the workers to behave in a manner which increases the possibility of failure. Therefore, the existing of Pygmalion Effect in an organization must be carefully managed and operationalized as it also has the potential to generate negative outcomes if leaders fail to manage it well.

### 1.8. Boiled Frog Syndrome

When a frog is dropped into a pot of boiling water it will immediately jump out from the pot. However, when a frog is placed in a pot of cool water and the water temperature is increased slowly, the frog will remain in the water until it is cooked as the temperature becomes higher the frog would have tolerated if dropped straight into the water (Boyatzis, 2006). Similarly, many people are like frogs as they are unable to detect and identify gradual but devastating life changes. Human minds often focus on isolated and immediate incidents, making it difficult to detect slow changes where there are long-term implications subtle changes in connections over time. Humans are better suited to accepting slow adjustments which accumulate in major changes, rather than those changes made drastically (Boyatzis, 2006).

### 1.9. Boiled Frog Syndrome in management

The Boiled Frog Syndrome has been utilized in the management discipline to raise awareness of the issues relating to the failure to detect environmental changes and the possible organizational damage resulting from failure to take timely and appropriate actions in response to changes. This syndrome is a useful reminder to managers and team members not to neglect any negative institutional inertia that has the potential to cause failure (Laplante, 2004) and to be aware of the sensitivity to initial conditions in the organization. The institutional inertia is frequently symbolized as the thermal inertia of the boiling water and therefore it will be a challenge for "frog managers" to become aware of this syndrome as it occurring (Laplante, 2004). Likely outcomes include higher labor absenteeism, higher rates of staff turnover, and a poor quality of work output (Richardson et al., 1994).

### 1.10. Parkinson's Law

The oft-cited "Parkinson's Law" was developed by the English Historian, Cyril Northcote Parkinson (Gutierrez & Kouvelis, 1991) to account for the phenomena that work expands to fill the time available for its completion (Parkinson, 1955). If any task was dragged until the last minute, it will take only one minute to be accomplished (Pannett et al., 2013). Parkinson (1955) further extended the law through the observation that there is no direct relationship between the number of the officials and the quantity of the work to be done. The argument was made by examining the behaviors of civil servants, where civil servant A may find his work load over-burdening and may request two assistants (B and C) to make the work more manageable. However, A must carefully select junior staff, perhaps less capable, so that they will not threaten A's position. However, when C starts to feel the work is demanding, he may also ask for some assistants. Then, to balance the situation, A must allocate two assistants for B as well. Here comes the civil servants D, E, F and G; together, the army of assistance raises the organizational position of A. The work that should be done by one person is now distributed to seven people. As more people get involved, the productivity is reduced (Parkinson, 1955).

### 1.11. Parkinson's Law in project management

Parkinson's Law has strong application in time management. The work will increase substantially with the time that a person could contribute to the activity (Bartoska & Subrt, 2011). Deadlines are an extremely important tool as it is human nature to allocate the work effort unevenly over the whole-time sequence, so the deadline will be the only consideration in carrying out the work (Bartoska & Subrt, 2011). When others set a deadline, it acts as a powerful motivator. Where activities lack a deadline, people will be less motivated and this could lead to the lack of achievement thereby leading to activity failure (Pannett et al., 2013). The common method to focus attention when

completing challenging and difficult tasks is to shorten the time required to complete the task (Millhiser & Szmerekovsky, 2012). This is also a method of managing effectively.

### 1.12. Bandwagon Effect

The Bandwagon Effect was proposed by David Luder, who stated that people tend to follow mainstream opinions without conducting their own investigation into the issue (Miller et al., 2009). It is a common phenomenon in every organization for people to adjust their behavior or opinions to align with the group's norm in order to be accepted by the group. furthermore, a group leader sometimes may use the Bandwagon Effects to exert strong pressure on a member to change his or her attitude and behavior. Thus, Bandwagon behaviors can have both rational- and irrational-effects when people prefer to conform to the beliefs of others and rely on information from others (Miller et al., 2009).

### 1.13. Bandwagon Effect in decision making

As a diffusion process, the Bandwagon Effect can have a great impact on organizational decision makers. When many other organizations have already accepted an idea, technique, technology or product, this pressure will then drive the decision maker to follow the crowd (Fiol & O'Connor, 2003). The implication of Bandwagon Effect is most obvious when the decision must be made under pressure and it can lead to the inaccuracy in the decision makers' perception of the problem (Fiol & O'Connor, 2003). When this occurs, there is a tendency for the organizational leader to simplify interpretations by relying on "cognitive shortcuts" to generate a solution or decision without investing further effort to secure more reliable information through active research (Fiol & O'Connor, 2003). Based on these discussions, the aim of this study is to map and understand which of these common Psychological Phenomena are the most prevalent phenomena in construction management. This should enable construction project managers to implement and use these concepts as tools to achieve their desired outcomes.

## 2. Research methods and procedures

In order to investigate the reflections of six psychological phenomena in construction project management, questionnaire surveys and structured interviews were conducted for two target groups: construction project participants (except project managers) and project managers. For construction project participants, a 23-items questionnaire was developed for data collection. The Partial Least Square (PLS) was used to investigate the correlations between six psychological phenomena and the demographics of project participants. For project managers, a pair-wise comparison form which contains a three-tiered model of construction projects, project objectives, and psychological phenomena was developed and scored by experienced project managers. The Fuzzy Analytic Hierarchy Process (FAHP) was used to identify the importance of six psychological phenomena to the project goals. It was a challenge for managers to evaluate and rank the priority of each of these psychological phenomena accurately due to the uncertainty and imprecision. This drove us to adopt the use of fuzzy set theory as Kahraman et al. (2004) asserted that it is able to effectively operate with the vagueness of human thought. Fuzzy set theory was first introduced by Zadeh (1965), and the algebraic operations with fuzzy numbers were developed by Chang (1996).

### 2.1. Questionnaire and pairwise comparison form

The questionnaire was divided into three parts: demographic information, general overview of construction project management and reflections of psychological phenomena. The psychological phenomena section had a total of 15 questions, which was further divided into six parts: Hedgehog Effect, Butterfly Effect, Pygmalion Effect, Boiled Frog Syndrome, Parkinson's Effect and Bandwagon Effect (see Appendix A). Questionnaires were distributed to construction project participants with an aim to investigate their psychological reflection in different situations. The project participants were then divided into groups so that the project manager can apply appropriate psychological theories to better address their issues based on different psychological reflection, as such ensuring all members are committed to the success of project. The pairwise comparison form consisted of four parts: demographic information, general overview of construction project management, reflections of psychological phenomena, and pairwise comparisons between different psychological phenomena (see Appendix B for a sample form). The main focus of the comparison form was Part D, which consisted of three criteria that contribute to the success of projects, namely time management, cost management, and quality management. Respondents were asked to assess the relative importance of six psychological phenomena (pairwise combination). The paired analysis form was thereafter sent to experienced project managers in the construction field. The purpose was to determine the importance of each psychological phenomenon in construction project management in terms of time management, cost management, and quality management. Project managers can be benefit from the findings by being aware of the psychological phenomena with the largest weights, as these are crucial for deciding project management.

### 2.2. Fuzzy analytic hierarchy process

According to Chang (1996), the membership function $\mu(x)$ of a triangular Fuzzy number is described as:

$$\mu(x)=\begin{cases}\dfrac{x-l}{m-l}, & x\in[l,m]\\ \dfrac{u-x}{u-m}, & x\in[m,u],\\ 0, & \text{otherwise}\end{cases} \tag{1}$$

where $l \le m \le u$, $l$ is the lower bounds while $u$ is the upper bounds. $m$ represents the modal value.

Taking $M_1$ and $M_2$ as two triangular fuzzy numbers, $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$. The operational laws are listed below:

$$(l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2 \ , m_1 + m_2 \ , u_1 + u_2); \quad (2)$$

$$(l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 l_2 \ , m_1 m_2 \ , u_1 u_2); \quad (3)$$

$$(\lambda, \lambda, \lambda) \otimes (l_1, m_1, u_1) = (\lambda l_1 \ , \lambda m_1 \ , \lambda u_1). \ \lambda > 0, \ \lambda \in R; \quad (4)$$

$$(l_1, m_1, u_1)^{-1} = \left( \frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1} \right). \quad (5)$$

Let $X = \{x_1, x_2, \ldots..x_n\}$ be an object set and $U = \{u_1, u_2, \ldots..u_n\}$ be the goal set. Each object is taken to perform the extent analysis for each goal. $m$ extent analysis values for each object can then be obtained as below:

$$M_{g_i}^1, M_{g_i}^2, \ldots\ldots\ldots, M_{g_i}^m, \quad i = 1,2,\ldots..n, \quad (6)$$

where all the $M_{g_i}^j \ (j = 1,2,\ldots,m)$ are fuzzy numbers. Let $M_{g_i}^1, M_{g_i}^2, \ldots, M_{g_i}^m$, be the values of the extent analysis of $i$-th object for m goals. The value of fuzzy synthetic extent with respect to the $i$-th object is defined as:

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes [\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j]^{-1}. \quad (7)$$

Let $A = (a_{ij})_{n \times m}$ be a fuzzy pairwise comparison matrix, where $a_{ij} = (l_{ij}, m_{ij}, u_{ij}), l_{ij} = \frac{1}{l_{ji}}, m_{ij} = \frac{1}{m_{ji}}, u_{ij} = \frac{1}{u_{ji}}$.

The degree of probability for $M_1 \ge M_2$ is defined as the equation below:

$$V\left( M_1 \ge M_2 = \sup_{x \ge y} [\min(\mu_{M_1}(x), \mu_{M_2}(y)) \right]. \quad (8)$$

When a pair $(x, y)$ exists such that $x \ge y$ and $\mu_{M_1}(x) = \mu_{M_2}(y)$. Since $M_1$ and $M_2$ are convex fuzzy members, therefore

$$V(M_1 \ge M_2) = 1 \text{ if } m_1 \ge m_2.$$

$$V(M_1 \ge M_2) = hgt(M_1 \cap M_2) = \mu_{M_1}(d), \quad (9)$$

where $d$ is the ordinate of the highest intersection point $D$ between $\mu_{M_1}$ and $\mu_{M_2}$.

When $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, the ordinate of $D$ is given by:

$$V(M_2 \ge M_1) = hgt(M_1 \cap M_2) =$$

$$\begin{cases} 1, & \text{if } m_2 \ge m_1 \\ 0, & \text{if } l_1 \ge u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise} \end{cases}. \quad (10)$$

In order to compare $M_1$ and $M_2$, both the values $V(M_1 \ge M_2)$ and $V(M_2 \ge M_1)$ are needed.

The degree possibility for a convex fuzzy number to be greater than k convex fuzzy numbers $M_i (i = 1,2,\ldots,k)$ can be defined as:

$$V(M \ge M_1, M_2, \ldots\ldots..., M_k) =$$

$$V[(M \ge M_1) \text{ and } (M \ge M_2) \text{ and } \ldots \text{ and } (M \ge M_k)] =$$

$$\min V(M \ge M_i), \ i = 1,2,\ldots,k. \quad (11)$$

Assume that

$$d'(A) = \min V(S_i \ge S_k), \quad (12)$$

for $k = 1,2,\ldots,n; k \ne i$. The weight vector is given following:

$$W' = (d'(A_1), d'(A_2), \ldots\ldots..., d'(A_n))^{\mathrm{T}}, \quad (13)$$

where $A_1 (i = 1,2,\ldots,n)$ are $n$ elements.

The normalized weight vectors are obtained through normalization.

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^{\mathrm{T}}, \quad (14)$$

where $W$ represents the non-fuzzy number.

## 3. Data interpretation and analysis

To ensure a high response rate, questionnaires and pairwise comparison forms were distributed either through email or collected on-the-spot within a week.

### 3.1. Questionnaire collection and analysis

40 sets of questionnaires were distributed face to face to construction practitioners who work in Jabatan Kerja Raya (JKR) with 32 valid forms returned. 200 questionnaires were sent to the construction firms by mail with 118 valid forms received. Therefore, a total of 150 valid forms collected and assessed, representing a 62.5% response rate. Table 1 shows the demographic information of respondents. Table 2 shows the results of reliability and validity tests.

Table 1. Demographic information of structured interview

| | Demographic Characteristics | Frequency | Percentage |
|---|---|---|---|
| 1. | **Gender** | | |
| | Male | 77 | 51.3% |
| | Female | 73 | 48.7% |
| 2. | **Age** | | |
| | 18–23 years old | 12 | 8.0% |
| | 24–30 years old | 74 | 49.3% |
| | 31–40 years old | 53 | 35.3% |
| | 41–50 years old | 7 | 4.7% |
| | Above 50 years old | 4 | 2.7% |
| 3. | **Working Experience** | | |
| | 1–2 years | 39 | 26.0% |
| | 3–5 years | 38 | 25.3% |
| | 6–10 years | 32 | 21.3% |
| | 11–15 years | 24 | 16.0% |
| | 16–20 years | 7 | 4.7% |
| | Above 10 years | 10 | 6.7% |
| 4. | **Educational Level** | | |
| | Primary | 0 | – |
| | Secondary | 0 | – |
| | Tertiary | 150 | 100% |
| 5. | **Sector** | | |
| | Public Sector | 48 | 32.0% |
| | Private Sector | 102 | 68.0% |

Table 2. Reliability and validity test

| Test Items | AVE | Composite Reliability | R Square | Cronbach's Alpha | Communality | Redundancy |
|---|---|---|---|---|---|---|
| Bandwagon | 0.3875 | 0.5596 | 0.0484 | –0.0511 | 0.3875 | 0.0013 |
| Boiled Frog | 0.4978 | 0.3742 | 0.0354 | 0.0211 | 0.4978 | 0.0101 |
| Butterfly | 1 | 1 | 0.1033 | 1 | 1 | 0.0024 |
| Experience | 1 | 1 | | 1 | 1 | |
| Gender | 1 | 1 | | 1 | 1 | |
| Hedgehog | 1 | 1 | 0.1183 | 1 | 1 | 0.1169 |
| Parkinson | 0.4867 | 0.2256 | 0.0087 | 0.0721 | 0.4867 | 0.0023 |
| Pygmalion | 0.5196 | 0.6261 | 0.1358 | 0.4427 | 0.5196 | 0.0524 |

Internal consistency reliability is the validity of different survey items used to measure the same trait, and is often assessed using the composite reliability value. The result should be larger than 0.6 in order to establish internal consistency reliability. Table 2 shows that neither the Boiled Frog syndrome nor the Parkinson's effect had a composite reliability of 0.374 or 0.225, respectively, showing that these two variables did not adequately characterize the internal consistency reliability. The average variance (AVE) extracted for each variable with a value greater than 0.5 was considered acceptable for convergence validity. Table 2 reveals that, with the exception of the Bandwagon effect, which has AVE value of only 0.388, all variables have AVE value greater than 0.5.

The PLS model was used to determine the association between respondents' gender, working experience and the six psychological phenomena The results were shown in Figure 1. Each circle in Figure 1 represented the coefficient of determination $R^2$ for the variable. When the $R^2$ is above 0.75, it is substantial; 0.50 is moderate; and 0.25 is weak. The $R^2$ values of the variables "Bandwagon", "Parkinson", "Boiled Frog", "Hedgehog", "Butterfly" and "Pygmalion" were 0.048, 0.009, 0.035, 0.118, 0.103 and 0.136, respectively. While the values from the model are weak, the purposes of this model are not predictive and so the low values are not deemed to be important. The inner model, indicating relative importance amongst variable associations, suggests the effect of one variable on another variable and working experience and gender were used as the exogenous variables. According to Figure 1, the $R^2$ values of the variables "Hedgehog" and "Pygmalion" for working experience were –0.337 and –0.340, respectively, indicating a strong association. The $R^2$ values of the variables "Bandwagon", "Parkinson", "Boiled Frog" and "Butterfly" for working experience were 0.052, –0.007, –0.128 and –0.024, respectively, indicating that a weak correlation. The $R^2$ value of the variable "Butterfly" for gender was 0.318, indicating a strong association. The $R^2$ values of the variables "Bandwagon", "Parkinson", "Boiled Frog", "Hedgehog" and "Pygmalion" for gender were –0.207, –0.063, 0.123 and –0.192, respectively, indicating that the correlations were very weak. Another

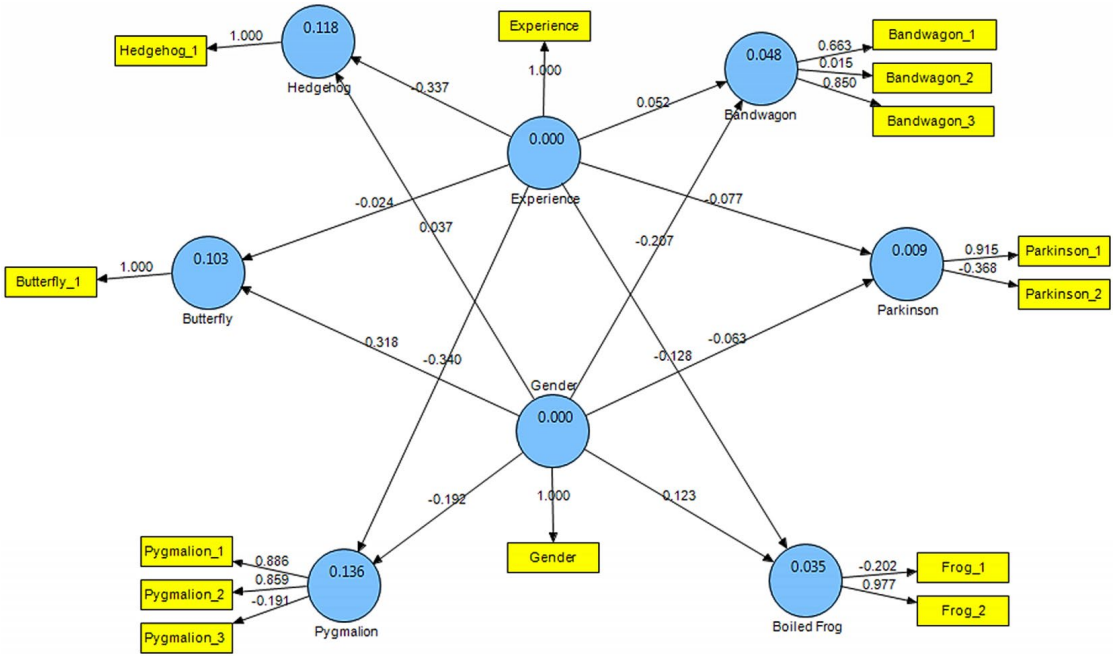


Figure 1. Partial least squares diagram for Psychological Phenomena

strong effect was the impact that "working experience" has on "Pygmalion Effect". The PLS bootstrapping procedure was used to check the structural path significance. T-statistics was generated in Figure 2. The path coefficient is deemed to be significant if the value is greater than 1.96. According to Figure 2, only three associations were found to be significant: Gender to Butterfly Effect (3.186); Working Experience to Hedgehog Effect (3.569); and Working Experience to Pygmalion Effect (3.945). As a result, these three pairs were selected for further correlation analysis.

The Psychological Phenomena by gender and working experience are summarized in Figure 3. The Hedgehog Effect is related to the working experience of interviewees, and the reasons for this being an important variable may be reflected in the result from the open-ended question. Interviewees with less working experiences generally believed that distance between team members would hinder the communication and would lead to inefficient and ineffective management process. Instead, they expected a closer relationship among team members – especially between the superiors and the subordinates – to harmonize the working environment. Those interviewees with more than six years of working experience, on other hand, believed that distance was necessary – especially between the superiors and the subordinates – so that the top management could have better control of team members. Furthermore, one cited benefit of some distance among team members is that leaders can make more rational decisions because they can avoid emotional issues.

The Pygmalion Effect is also associated with working experience; interviewees with more than sixteen years of experience believed that setting higher expectations was a motivating method. In contrast, participants with less than sixteen years of experience did not support this, instead expressing the connection between stress and high expectations. The Boiled Frog Syndrome was not influenced by gender or working experience. The majority of interviewees (70%) agreed that slow and gradual changes were more acceptable. However, when the changes exceeded the tolerable limit, there are three possible responses: bear it, express dissatisfaction towards the higher-level managers, or start to look for another job. The majority of interviewees chose to bear the changes, with only 10% looking for a new job opportunity. In terms of Parkinson's Law, all interviewees agreed that setting a goal or deadline could improve efficiency. Regarding to Bandwagon Effect, all interviewees agreed that there is less tendency to make a mistake if they follow along with the mainstream opinions. When their opinion differed from that of others, most interviewees (69%) chose to keep quiet.

### 3.2. Result of fuzzy analysis

After reviewing the theories underlying each psychological phenomenon, six project management experts were invited to finish the fuzzy logic questionnaire. Because fuzzy logic is an analysis approach that emphasizes the qualification of the respondents, the respondents were carefully selected to ensure the validity of the study. This study includes only experienced project managers with more than ten years of experience. The questionnaire was divided into two sections. The first section was to determine which criterion (time, cost or quality) is most important to achieve the goal of good project management. The second section focused on the relative importance of each psychological phenomenon in terms of time management, cost management and quality management. The purpose of this fuzzy test was to determine how these Psychological Phenomena impacted on project management in terms of time management, cost management, and quality management.

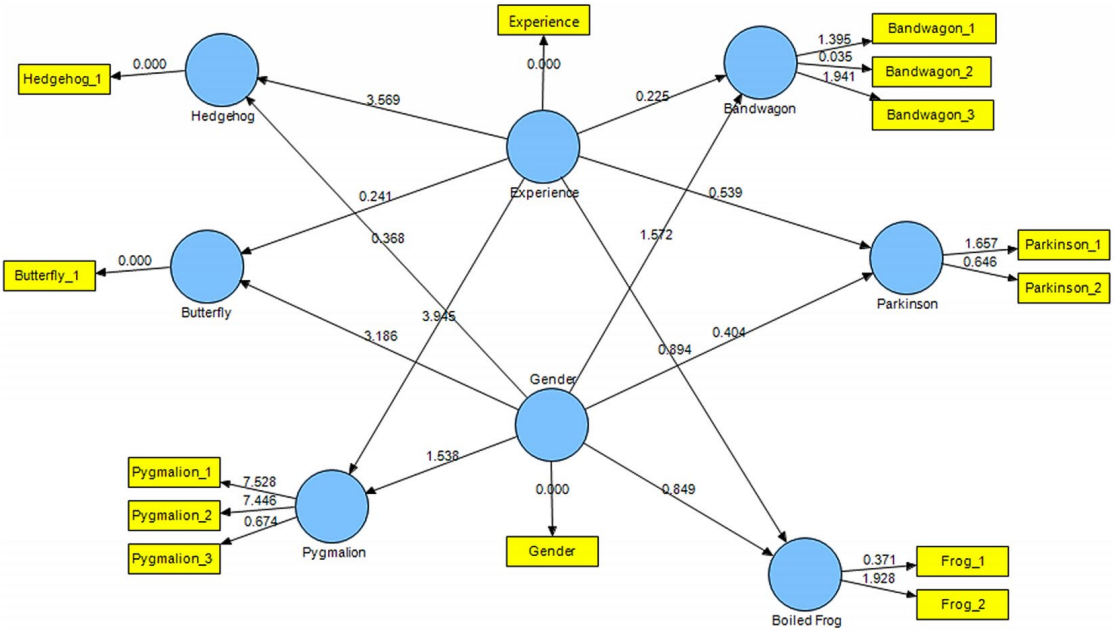


Figure 2. Partial least squares bootstrapping for Psychological Phenomena

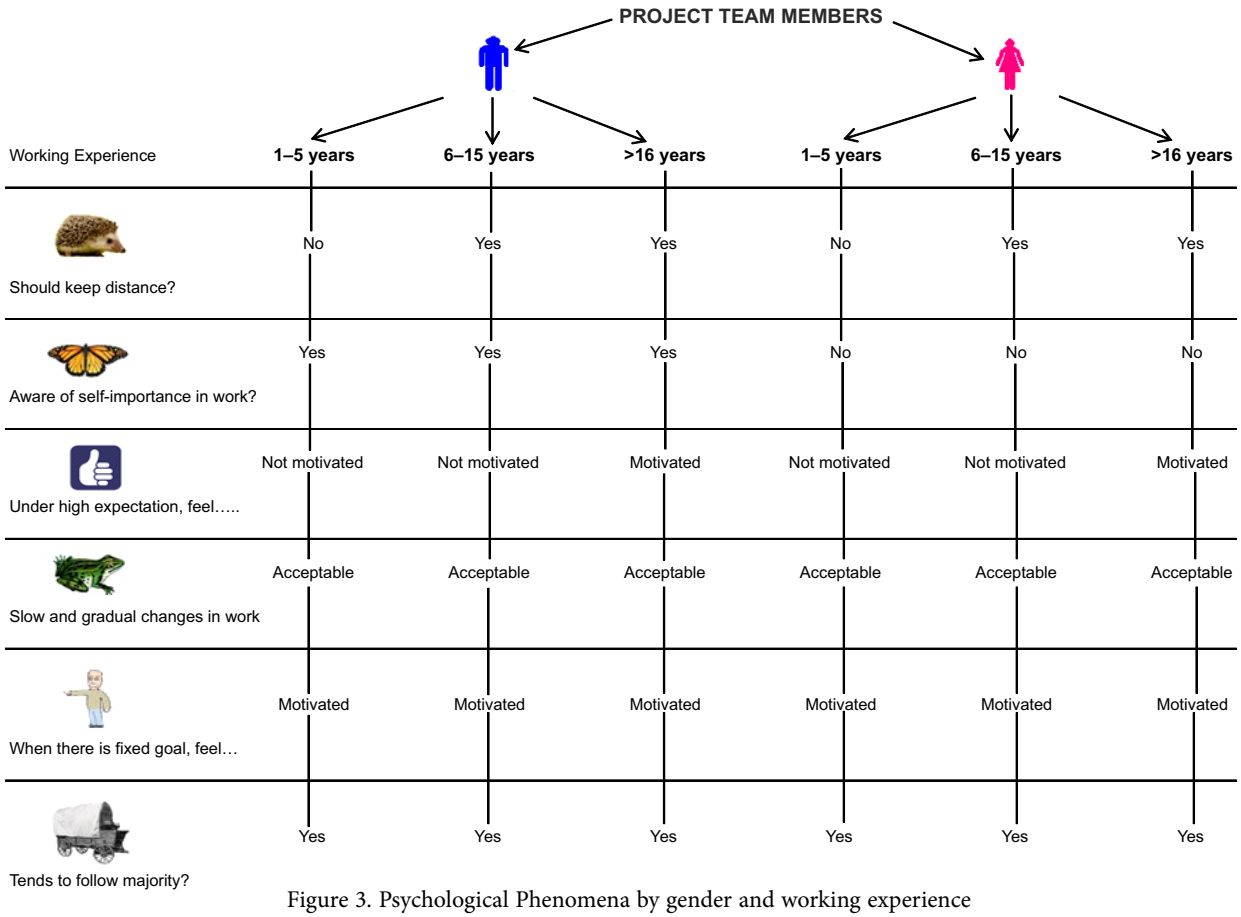


Figure 3. Psychological Phenomena by gender and working experience

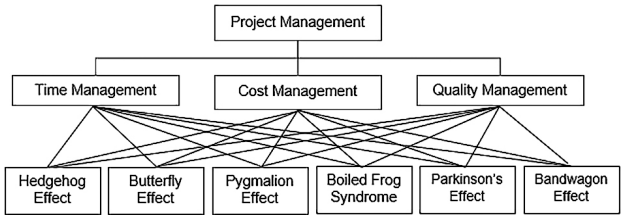


Figure 4. Fuzzy hierarchy for Psychological Phenomena and project management

The fuzzy hierarchy for psychological phenomena and project management is shown in Figure 4. In general, FAHP involves three layers. The goal layer is the overall goal of the project; the second layer is the composition of the project goal, which includes time, cost and quality; the third layer is the six psychological phenomena that affect the project goal. FAHP was used to analyse pairwise comparison forms. The weight of each indicator can be obtained using fuzzy logic to determine the importance of each phenomenon. The fuzzy triangular numbers and fuzzy comprehensive values were computed according to the principles and formulas described in Section 2.2.

Table 3 shows the experts' fuzzy numbers for time, cost and quality, and Table 4 shows the weight calculation process. A fuzzy comparison matrix of project time, cost, and quality management is presented in Table 5. Table 6 shows the contribution factors of each group based on expert's average work experience.

The weights WG of time management, cost management and quality management were computed according to Eqns (13) and (14). Table 5 shows the weights of time, cost and quality management were basically equal, indicating that the project manager believes that time management, cost management and quality management are equally important to project management. Table 7 shows a fuzzy comparison matrix with respect to time, cost and quality management. The calculation process of weights is shown in Table 8.

According to Table 7, Pygmalion Effect (WG = 0.56) and Parkinson's Law (WG = 0.44) have a direct impact on time management. Effective cost management, on the other hand, must account for the Boiled Frog Syndrome (WG = 0.28) and Parkinson's Law (WG = 0.72). Similarly, for quality management, the Boiled Frog Syndrome (WG = 0.63) and the Parkinson's Law (WG = 0.37) are the Psychological Phenomena that managers should be most concerned with. Based on the result, the Butterfly Effect (WG = 0), Hedgehog Effect (WG = 0), and Bandwagon Effect (WG = 0) have no direct association with time, cost, and quality in construction management.

Figure 5 depicts a fuzzy comparison matrix where the circle size and the different coloured areas represent the relative importance of the factors. The outermost ellipse represents the entire project management process, and the three circles in the middle represent time management, cost management, and quality management, respectively.

Table 3. Criteria with respect to time, cost, and quality

| Project Management Criteria | | Time | | Cost | | Quality | |
|---|---|---|---|---|---|---|---|
| | | Scale | TFN | Scale | TFN | Scale | TFN |
| Time | 0.11 | (1, 1, 1) | (1.00, 1.00, 1.00) | (1, 1, 1) | (2.27, 2.56, 2.86) | (1, 1, 1) | (0.37, 0.40, 0.43) |
| | 0.23 | (1, 1, 1) | | (1, 1, 1) | | (2/7, 1/3, 2/5) | |
| | 0.19 | (1, 1, 1) | | (9/2, 5, 11/2) | | (2/11, 1/5, 2/9) | |
| | 0.23 | (1, 1, 1) | | (5/2, 3, 7/2) | | (2/11, 1/5, 2/9) | |
| | 0.07 | (1, 1, 1) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.17 | (1, 1, 1) | | (5/2, 3, 7/2) | | (2/7, 1/3, 2/5) | |
| | | Aggregation | | | | | |
| Cost | 0.11 | (1, 1, 1) | (0.56, 0.58, 0.61) | (1, 1, 1) | (1.00, 1.00, 1.00) | (1, 1, 1) | (1.94, 2.14, 2.34) |
| | 0.23 | (1, 1, 1) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.19 | (2/11, 1/5, 2/9) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.23 | (2/7, 1/3, 2/5) | | (1, 1, 1) | | (5/2, 3, 7/2) | |
| | 0.07 | (1, 1, 1) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.17 | (2/7, 1/3, 2/5) | | (1, 1, 1) | | (9/2, 5, 11/2) | |
| | | Aggregation | | | | | |
| Quality | 0.11 | (1, 1, 1) | (3.07, 3.48, 3.89) | (1, 1, 1) | (0.70, 0.71, 0.73) | (1, 1, 1) | (1.00, 1.00, 1.00) |
| | 0.23 | (5/2, 3, 7/2) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.19 | (9/2, 5, 11/2) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.23 | (9/2, 5, 11/2) | | (2/7, 1/3, 2/5) | | (1, 1, 1) | |
| | 0.07 | (1, 1, 1) | | (1, 1, 1) | | (1, 1, 1) | |
| | 0.17 | (5/2, 3, 7/2) | | (2/11, 1/5, 2/9) | | (1, 1, 1) | |
| | | Aggregation | | | | | |

Table 4. Calculation of weightage for criteria with respect to "Project Management"

| Time | Cost | Quality |
|---|---|---|
| $S_{Time} = (3.64, 3.96, 4.29) \otimes \left(\frac{1}{13.86}+\frac{1}{12.87}+\frac{1}{1.91}\right) = (0.26, 0.31, 2.25)$ | $S_{Cost} = (3.50, 3.72, 3.95) \otimes \left(\frac{1}{13.86}+\frac{1}{12.87}+\frac{1}{1.91}\right) = (0.25, 0.29, 2.07)$ | $S_{Quality} = (4.77, 5.19, 5.62) \otimes \left(\frac{1}{13.86}+\frac{1}{12.87}+\frac{1}{1.91}\right) = (0.34, 0.40, 2.94)$ |
| By using Eqns (9) and (10):<br>$V(S_{time} \geq S_{cost}) = 1$<br>$V(S_{time} \geq S_{quality}) = \frac{0.34-2.25}{(0.31-2.25)-(0.40-0.34)} = 0.955$<br>$V(S_{cost} \geq S_{time}) = \frac{0.26-2.07}{(0.29-2.07)-(0.31-0.26)} = 0.989$<br>$V(S_{cost} \geq S_{quality}) = \frac{0.34-2.07}{(0.29-2.07)-(0.40-0.34)} = 0.940$<br>$V(S_{quality} \geq S_{time}) = 1$<br>$V(S_{quality} \geq S_{cost}) = 1$ | | |
| By using Eqns (9) and (10):<br>d' (Time) = V ($S_{Time} \geq S_{Cost}$, $S_{Quality}$) = min (1, 0.955) = 0.955 | By using Eqns (9) and (10):<br>d' (Cost) = V ($S_{Cost} \geq S_{Time}$, $S_{Quality}$) = min (0.989, 0.940) = 0.940 | By using Eqns (9) and (10):<br>d' (Quality) = V ($S_{Quality} \geq S_{Time}$, SCost) = min (1 , 1) = 1 |
| $W' = (0.955, 0.940, 1.000)^T$ | | |
| $W = (0.33, 0.32, 0.35)^T$ | | |

Table 5. Fuzzy comparison matrix

| Matrix | Time | Cost | Quality | $W_G$ |
|---|---|---|---|---|
| Time | (1.00,1.00, 1.00) | (2.27, 2.56 ,2.86) | (0.37, 0.40 ,0.43) | 0.33 |
| Cost | (0.56, 0.58, 0.61) | (1.00, 1.00, 1.00) | (1.94, 2.14, 2.34) | 0.32 |
| Quality | (3.07, 3.48, 3.89) | (0.70, 0.71, 0.73) | (1.00, 1.00, 1.00) | 0.35 |

Each psychological phenomenon is represented by an icon, and the colored area that occupied by the phenomenon represents its weight. Because the weights of time management, cost management, and quality management were 0.33, 0.32, and 0.35 (see Table 3), respectively, indicating the three circles were roughly the same size. These three factors are undeniably important in any construction project and are always identified as the project's main objectives. All surveyed experts agreed that the six chosen psychological phenomena all contribute to the success of any construction project management. According to the fuzzy analysis, the project managers believe the Parkinson's Effect and Pygmalion Effect both play an important role in time management. Boiled Frog Syndrome and Parkinson's Effect were found to be far more significant in terms of cost management and quality management. Although the Butterfly Effect, Bandwagon Effect and Hedgehog Effect were not considered in the time, cost and quality management, this is not to say that these three effects do not exist in the construction project management, but may indicates that those experienced project managers are much more concerned on another three psychological phenomena based on their working experience in this field.

Table 6. Six groups and respective contribution factors

| Group | Average Working Experience (Year) | Contribution Factor |
|---|---|---|
| E1 | 10 | 0.07 |
| E2 | 15 | 0.11 |
| E3 | 22 | 0.17 |
| E4 | 25 | 0.19 |
| E5 | 30 | 0.23 |
| E6 | 30 | 0.23 |
| Total | 132 | 1.00 |

Table 7. Fuzzy comparison matrix with respect to time, cost, and quality management

| Fuzzy comparison matrix with respect to "Time Management" | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hedgehog | Butterfly | Pygmalion | Frog | Parkinson | Bandwagon | $W^T$ |
| Hedgehog | (1.00, 1.00, 1.00) | (1.16, 1.38, 1.61) | (0.17, 0.19, 0.21) | (1.62, 1.84, 2.07) | (0.92, 1.05, 1.18) | (0.86, 1.00, 1.13) | 0 |
| Butterfly | (1.83, 3.70, 4.02) | (1.00, 1.00, 1.00) | (0.85, 0.92, 0.99) | (2.87, 3.22, 3.57) | (1.15, 1.22, 1.31) | (2.81, 3.07, 3.35) | 0 |
| Pygmalion | (5.48, 5.98, 6.48) | (5.52, 5.97, 6.41) | (1.00, 1.00, 1.00) | (1.13, 1.27, 1.42) | (1.50, 1.71, 1.91) | (2.60, 2.92, 3.24) | 0.56 |
| Frog | (3.37, 3.67, 3.98) | (0.46, 0.49, 0.52) | (1.76, 1.95, 2.13) | (1.00, 1.00, 1.00) | (0.41, 0.42, 0.44) | (2.31, 2.63, 2.94) | 0 |
| Parkinson | (3.42, 3.69, 3.96) | (2.93, 3.23, 3.52) | (1.32, 1.39, 1.48) | (4.01, 4.36, 4.71) | (1.00, 1.00, 1.00) | (3.46, 3.82, 4.19) | 0.44 |
| Bandwagon | (3.10, 3.41, 3.72) | (1.59, 1.82, 2.04) | (1.22, 1.33, 1.44) | (1.13, 1.21, 1.30) | (0.87, 1.03, 1.20) | (1.00, 1.00, 1.00) | 0 |
| Fuzzy comparison matrix with respect to "Cost Management" | | | | | | | |
| | Hedgehog | Butterfly | Pygmalion | Frog | Parkinson | Bandwagon | $W^T$ |
| Hedgehog | (1.00, 1.00, 1.00) | (0.85, 0.98, 1.10) | (0.47, 0.53, 0.58) | (0.32, 0.38, 0.43) | (0.52, 0.53, 0.54) | (0.49, 0.54, 0.60) | 0 |
| Butterfly | (3.72, 4.17, 4.47) | (1.00, 1.00, 1.00) | (1.41, 1.52, 1.64) | (1.23, 1.33, 1.44) | (1.13, 1.19, 1.27) | (2.48, 2.77, 3.08) | 0 |
| Pygmalion | (4.67, 5.05, 5.44) | (1.48, 1.70, 1.91) | (1.00, 1.00,1.00) | (0.37, 0.39, 0.41) | (0.22, 0.25, 0.29) | (2.72, 3.07, 3.43) | 0 |
| Frog | (5.77, 6.23, 6.70) | (3.34, 3.64, 3.94) | (4.78, 5.14, 5.53) | (1.00, 1.00, 1.00) | (0.38, 0.39, 0.42) | (2.71, 2.99, 3.28) | 0.28 |
| Parkinson | (4.76, 5.02, 5.29) | (3.39, 3.69, 3.98) | (4.42, 4.92, 5.42) | (4.20, 4.58, 4.97) | (1.00, 1.00, 1.00) | (3.93, 4.29, 4.65) | 0.72 |
| Bandwagon | (3.83, 4.21, 4.60) | (1.47, 1.67, 1.87) | (1.72, 1.89, 2.07) | (0.66, 0.71, 0.77) | (0.77, 0.90, 1.03) | (1.00, 1.00, 1.00) | 0 |
| Fuzzy comparison matrix with respect to "Quality Management" | | | | | | | |
| | Hedgehog | Butterfly | Pygmalion | Frog | Parkinson | Bandwagon | $W^T$ |
| Hedgehog | (1.00, 1.00, 1.00) | (2.47, 2.68, 2.89) | (0.35, 0.37, 0.39) | (1.38, 1.49, 1.60) | (0.33, 0.36, 0.38) | (1.75, 1.94, 2.13) | 0 |
| Butterfly | (3.00, 3.18, 3.36) | (1.00, 1.00, 1.00) | (1.43, 1.56, 1.69) | (0.58, 0.59, 0.60) | (0.54, 0.55, 0.56) | (0.44, 0.46, 0.48) | 0 |
| Pygmalion | (4.38, 4.78, 5.19) | (2.34, 2.58, 2.82) | (1.00, 1.00, 1.00) | (1.20, 1.35, 1.51) | (0.97, 1.10, 1.24) | (1.11, 1.23, 1.35) | 0 |
| Frog | (4.47, 4.88, 5.28) | (3.93, 4.16, 4.40) | (2.06, 2.22, 2.39) | (1.00, 1.00, 1.00) | (2.50, 2.75, 3.01) | (3.98, 4.44, 4.91) | 0.63 |
| Parkinson | (4.50, 4.90, 5.31) | (3.84, 4.10, 4.37) | (2.32, 2.57, 2.82) | (0.71, 0.76, 0.81) | (1.00, 1.00, 1.00) | (3.76, 4.21, 4.65) | 0.37 |
| Bandwagon | (4.09, 4.42, 4.76) | (3.33, 3.68, 4.03) | (2.04, 2.19, 2.34) | (0.27, 0.30, 0.33) | (0.90, 0.98, 1.06) | (1.00, 1.00, 1.00) | 0 |

Table 8. Calculation of weightage for Psychological Phenomena with respect to time, cost, and quality management

| Hedgehog | Butterfly | Pygmalion | Frog | Parkinson | Bandwagon |
|---|---|---|---|---|---|
| $S_{Hedgehog}$ = (5.73, 6.46, 7.20) ⊗ $\left(\frac{1}{82.47}+\frac{1}{75.89}+\frac{1}{67.83}\right)$ = (0.06, 0.09, 0.11) | $S_{Butterfly}$ = (10.51, 13.13, 14.24) ⊗ $\left(\frac{1}{82.47}+\frac{1}{75.89}+\frac{1}{67.83}\right)$ = (0.13, 0.17, 0.21) | $S_{Pygmalion}$ = (17.23, 18.85, 20.46) ⊗ $\left(\frac{1}{82.47}+\frac{1}{75.89}+\frac{1}{67.83}\right)$ = (0.21, 0.25, 0.30) | $S_{Frog}$ = (9.31, 10.16, 11.01) ⊗ $\left(\frac{1}{82.47}+\frac{1}{75.89}+\frac{1}{67.83}\right)$ = (0.11, 0.13, 0.16) | $S_{Parkinson}$ = (16.14, 17.49, 18.86) ⊗ $\left(\frac{1}{82.47}+\frac{1}{75.89}+\frac{1}{67.83}\right)$ = (0.20, 0.23, 0.28) | $S_{Bandwagon}$ = (8.91, 9.80, 10.70) ⊗ $\left(\frac{1}{82.47}+\frac{1}{75.89}+\frac{1}{67.83}\right)$ = (0.11, 0.13, 0.16) |
| $V(S_{Hedgehog} \geq S_{Butterfly}) = 0$<br>$V(S_{Hedgehog} \geq S_{Pygmalion}) = 0$<br>$V(S_{Hedgehog} \geq S_{Frog}) = 0$<br>$V(S_{Hedgehog} \geq S_{Parkinson}) = 0$<br>$V(S_{Hedgehog} \geq S_{Bandwagon}) = 0$ | $V(S_{Butterfly} \geq S_{Hedgehog}) = 1$<br>$V(S_{Butterfly} \geq S_{Pygmalion}) = 0$<br>$V(S_{Butterfly} \geq S_{Frog}) = 1$<br>$V(S_{Butterfly} \geq S_{Parkinson})$ = 0.20 – 0.21(0.17 – 0.21) – (0.23 – 0.20) = 0.143<br>$V(S_{Butterfly} \geq S_{Bandwagon}) = 1$ | $V(S_{Pygmalion} \geq S_{Hedgehog}) = 1$<br>$V(S_{Pygmalion} \geq S_{Butterfly}) = 1$<br>$V(S_{Pygmalion} \geq S_{Frog}) = 1$<br>$V(S_{Pygmalion} \geq S_{Parkinson}) = 1$<br>$V(S_{Pygmalion} \geq S_{Bandwagon}) = 1$ | $V(S_{Frog} \geq S_{Hedgehog}) = 1$<br>$V(S_{Frog} \geq S_{Butterfly})$ = 0.13 – 0.16(0.13 – 0.16) – (0.17 – 0.13) = 0.429<br>$V(S_{Frog} \geq S_{Pygmalion}) = 0$<br>$V(S_{Frog} \geq S_{Parkinson}) = 0$<br>$V(S_{Frog} \geq S_{Bandwagon}) = 1$ | $V(S_{Parkinson} \geq S_{Hedgehog}) = 1$<br>$V(S_{Parkinson} \geq S_{Butterfly}) = 1$<br>$V(S_{Parkinson} \geq S_{Pygmalion})$ = 0.21 – 0.28(0.23 – 0.28) – (0.25 – 0.21) = 0.778<br>$V(S_{Parkinson} \geq S_{Frog}) = 1$<br>$V(S_{Parkinson} \geq S_{Bandwagon}) = 1$ | $V(S_{Bandwagon} \geq S_{Hedgehog}) = 1$<br>$V(S_{Bandwagon} \geq S_{Butterfly})$ = 0.13 – 0.16(0.13 – 0.16) – (0.25 – 0.21) = 0.429<br>$V(S_{Bandwagon} \geq S_{Pygmalion}) = 0$<br>$V(S_{Bandwagon} \geq S_{Frog}) = 1$<br>$V(S_{Bandwagon} \geq S_{Parkinson}) = 0$ |
| d' (Hedgehog) = $V(S_{Hedgehog} \geq S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (0, 0, 0, 0, 0) = 0 | d' (Butterfly) = $V(S_{Butterfly} \geq S_{Hedgehog}, S_{Pygmalion}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 0, 1, 0.143, 1) = 0 | d' (Pygmalion) = $V(S_{Pygmalion} \geq S_{Hedgehog}, S_{Butterfly}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 1, 1, 1, 1) = 1 | d' (Frog) = $V(S_{Frog} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 0.429, 0, 0, 1) = 0 | d' (Parkinson) = $V(S_{Parkinson} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Bandwagon})$ = min (1, 1, 0.778, 1, 1) = 0.778 | d' (Bandwagon) = $V(S_{Bandwagon} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Parkinson})$ = min (1, 0.429, 0, 1, 0) = 0 |
| Time Management W (0, 0, 0.56, 0, 0.44, 0)$^T$ | | | | | |
| Hedgehog | Butterfly | Pygmalion | Frog | Parkinson | Bandwagon |
| $S_{Hedgehog}$ = (3.65, 3.96, 4.25) ⊗ $\left(\frac{1}{87.15}, \frac{1}{80.67}, \frac{1}{74.21}\right)$ = (0.04, 0.05, 0.06) | $S_{Butterfly}$ = (10.97, 11.98, 12.90) ⊗ $\left(\frac{1}{87.15}, \frac{1}{80.67}, \frac{1}{74.21}\right)$ = (0.13, 0.15, 0.17) | $S_{Pygmalion}$ = (10.46, 11.46, 12.48) ⊗ $\left(\frac{1}{87.15}, \frac{1}{80.67}, \frac{1}{74.21}\right)$ = (0.12, 0.14, 0.17) | $S_{Frog}$ = (17.98, 19.39, 20.87) ⊗ $\left(\frac{1}{87.15}, \frac{1}{80.67}, \frac{1}{74.21}\right)$ = (0.21, 0.24, 0.28) | $S_{Parkinson}$ = (21.70, 23.50, 25.31) ⊗ $\left(\frac{1}{87.15}, \frac{1}{80.67}, \frac{1}{74.21}\right)$ = (0.25, 0.29, 0.34) | $S_{Bandwagon}$ = (9.45, 10.38, 11.34) ⊗ $\left(\frac{1}{87.15}, \frac{1}{80.67}, \frac{1}{74.21}\right)$ = (0.11, 0.13, 0.15) |
| By using Eqns (9) and (10),<br>$V(S_{Hedgehog} \geq S_{Butterfly}) = 0$<br>$V(S_{Hedgehog} \geq S_{Pygmalion}) = 0$<br>$V(S_{Hedgehog} \geq S_{Frog}) = 0$<br>$V(S_{Hedgehog} \geq S_{Parkinson}) = 0$<br>$V(S_{Hedgehog} \geq S_{Bandwagon}) = 0$ | $V(S_{Butterfly} \geq S_{Hedgehog}) = 1$<br>$V(S_{Butterfly} \geq S_{Pygmalion}) = 1$<br>$V(S_{Butterfly} \geq S_{Frog}) = 0$<br>$V(S_{Butterfly} \geq S_{Parkinson}) = 0$<br>$V(S_{Butterfly} \geq S_{Bandwagon}) = 1$ | $V(S_{Pygmalion} \geq S_{Hedgehog}) = 1$<br>$V(S_{Pygmalion} \geq S_{Butterfly})$ = 0.13 – 0.17(0.14 – 0.17) – (0.15 – 0.13) = 0.80<br>$V(S_{Pygmalion} \geq S_{Frog}) = 0$<br>$V(S_{Pygmalion} \geq S_{Parkinson}) = 0$<br>$V(S_{Pygmalion} \geq S_{Bandwagon}) = 1$ | $V(S_{Frog} \geq S_{Hedgehog}) = 1$<br>$V(S_{Frog} \geq S_{Butterfly}) = 1$<br>$V(S_{Frog} \geq S_{Pygmalion}) = 1$<br>$V(S_{Frog} \geq S_{Parkinson})$ = 0.25 – 0.28(0.24 – 0.28) – (0.29 – 0.25) = 0.375<br>$V(S_{Frog} \geq S_{Bandwagon}) = 1$ | $V(S_{Parkinson} \geq S_{Hedgehog}) = 1$<br>$V(S_{Parkinson} \geq S_{Butterfly}) = 1$<br>$V(S_{Parkinson} \geq S_{Pygmalion}) = 1$<br>$V(S_{Parkinson} \geq S_{Frog}) = 1$<br>$V(S_{Parkinson} \geq S_{Bandwagon}) = 1$ | $V(S_{Bandwagon} \geq S_{Hedgehog}) = 1$<br>$V(S_{Bandwagon} \geq S_{Butterfly})$ = 0.13 – 0.15 (0.13 – 0.15) – (0.15 – 0.13) = 0.50<br>$V(S_{Bandwagon} \geq S_{Pygmalion})$ = 0.12 – 0.15 (0.13 – 0.15) – (0.14 – 0.12) = 0.75<br>$V(S_{Bandwagon} \geq S_{Frog}) = 0$<br>$V(S_{Bandwagon} \geq S_{Parkinson}) = 0$ |
| d' (Hedgehog) = $V(S_{Hedgehog} \geq S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Parkinso}, S_{Bandwagon})$ = min (0, 0, 0, 0, 0) = 0 | d' (Butterfly) = $V(S_{Butterfly} \geq S_{Hedgehog}, S_{Pygmalion}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 1, 0, 0, 1) = 0 | d' (Pygmalion) = $V(S_{Pygmalion} \geq S_{Hedgehog}, S_{Butterfly}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 0.80, 0, 0, 1) = 0 | d' (Frog) = $V(S_{Frog} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 1, 1, 0.375,1) = 0.375 | d' (Parkinson) = $V(S_{Parkinson} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Bandwagon})$ = min (1, 1, 1, 1, 1) = 1 | d' (Bandwagon) = $V(S_{Bandwagon} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Parkinson})$ = min (1, 0.50 ,0.75, 0, 0) = 0 |
| Cost Management: W (0, 0, 0, 0.28, 0.72, 0)$^T$ | | | | | |
| Hedgehog | Butterfly | Pygmalion | Frog | Parkinson | Bandwagon |
| $S_{Hedgehog}$ = (7.28, 7.84, 8.39) ⊗ $\left(\frac{1}{82.66}, \frac{1}{76.78}, \frac{1}{70.97}\right)$ = (0.08, 0.10, 0.11) | $S_{Butterfly}$ = (6.99, 7.34, 7.69) ⊗ $\left(\frac{1}{82.66}, \frac{1}{76.78}, \frac{1}{70.97}\right)$ = (0.08, 0.09, 0.10) | $S_{Pygmalion}$ = (11.00, 12.04, 13.11) ⊗ $\left(\frac{1}{82.66}, \frac{1}{76.78}, \frac{1}{70.97}\right)$ = (0.13, 0.16, 0.17) | $S_{Frog}$ = (17.94, 19.45, 20.99) ⊗ $\left(\frac{1}{82.66}, \frac{1}{76.78}, \frac{1}{70.97}\right)$ = (0.22, 0.25, 0.27) | $S_{Parkinson}$ = (16.13, 17.54, 18.96) ⊗ $\left(\frac{1}{82.66}, \frac{1}{76.78}, \frac{1}{70.97}\right)$ = (0.20, 0.23, 0.25) | $S_{Bandwagon}$ = (11.63, 12.57, 13.52) ⊗ $\left(\frac{1}{82.66}, \frac{1}{76.78}, \frac{1}{70.97}\right)$ = (0.14, 0.16, 0.18) |
| $V(S_{Hedgehog} \geq S_{Butterfly}) = 1$<br>$V(S_{Hedgehog} \geq S_{Pygmalion}) = 0$<br>$V(S_{Hedgehog} \geq S_{Frog}) = 0$<br>$V(S_{Hedgehog} \geq S_{Parkinson}) = 0$<br>$V(S_{Hedgehog} \geq S_{Bandwagon}) = 0$ | $V(S_{Butterfly} \geq S_{Hedgehog})$ = 0.08 – 0.1 (0.09 – 0.10) – (0.10 – 0.08) = 0.667<br>$V(S_{Butterfly} \geq S_{Pygmalion}) = 0$<br>$V(S_{Butterfly} \geq S_{Frog}) = 0$<br>$V(S_{Butterfly} \geq S_{Parkinson}) = 0$<br>$V(S_{Butterfly} \geq S_{Bandwagon}) = 0$ | $V(S_{Pygmalion} \geq S_{Hedgehog}) = 1$<br>$V(S_{Pygmalion} \geq S_{Butterfly}) = 1$<br>$V(S_{Pygmalion} \geq S_{Frog}) = 0$<br>$V(S_{Pygmalion} \geq S_{Parkinson}) = 0$<br>$V(S_{Pygmalion} \geq S_{Bandwagon}) = 1$ | $V(S_{Frog} \geq S_{Hedgehog}) = 1$<br>$V(S_{Frog} \geq S_{Butterfly}) = 1$<br>$V(S_{Frog} \geq S_{Pygmalion}) = 1$<br>$V(S_{Frog} \geq S_{Parkinson}) = 1$<br>$V(S_{Frog} \geq S_{Bandwagon}) = 1$ | $V(S_{Parkinson} \geq S_{Hedgehog}) = 1$<br>$V(S_{Parkinson} \geq S_{Butterfly}) = 1$<br>$V(S_{Parkinson} \geq S_{Pygmalion}) = 1$<br>$V(S_{Parkinson} \geq S_{Frog}) = 0.22$ – 0.25(0.23 – 0.25) – (0.25 – 0.22) = 0.60<br>$V(S_{Parkinson} \geq S_{Bandwagon}) = 1$ | $V(S_{Bandwagon} \geq S_{Hedgehog}) = 1$<br>$V(S_{Bandwagon} \geq S_{Butterfly}) = 1$<br>$V(S_{Bandwagon} \geq S_{Pygmalion}) = 1$<br>$V(S_{Bandwagon} \geq S_{Frog}) = 0$<br>$V(S_{Bandwagon} \geq S_{Parkinson}) = 0$ |
| d' (Hedgehog) = $V(S_{Hedgehog} \geq S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 0, 0, 0, 0) = 0 | d' (Butterfly) = $V(S_{Butterfly} \geq S_{Hedgehog}, S_{Pygmalion}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (0.67, 0, 0, 0, 0) = 0 | d' (Pygmalion) = $V(S_{Pygmalion} \geq S_{Hedgehog}, S_{Butterfly}, S_{Frog}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 1, 0, 0, 1) = 0 | d' (Frog) = $V(S_{Frog} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Parkinson}, S_{Bandwagon})$ = min (1, 1, 1, 1, 1) = 1 | d' (Parkinson) = $V(S_{Parkinson} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Frog}, S_{Bandwagon})$ = min (1, 1, 1, 0.60, 1) = 0.60 | d' (Bandwagon) = $V(S_{Bandwagon} \geq S_{Hedgehog}, S_{Butterfly}, S_{Pygmalion}, S_{Frog}, SP_{arkinson})$ = min (1, 1, 1, 0, 0) = 0 |
| Quality Management: W (0, 0, 0, 0.63, 0.37, 0)$^T$ | | | | | |

### 3.3. Discussion on findings

Males and females may respond differently in similar circumstances, presenting us with gender stereotypes (Heilman, 2012); in research, this is sometimes reflected by the use of gender as a moderating variable. This study found female construction managers have less awareness of the Butterfly Effect, whereby they might consider that every step or decision they make is important as the outcome may affect the overall project outcome. Beyer (1990) stated that it is generally more likely that males either accurately- or over-estimate their own ability; however, women are more likely to either accurately- or under-estimate their ability. In contrast, our findings indicate that among construction project managers, females present greater self-confidence than males, thus leading women to be more likely to neglect the Butterfly Effect. This might be due to the nature of the construction sector, where the dominance of males workers means that a female manager might feel the need to perform more dominantly to exert leadership over her male teams. Working experience determines the competency of the workers. This study discovered that Hedgehog Effect and Pygmalion Effect are influenced greatly by working experience. For example,

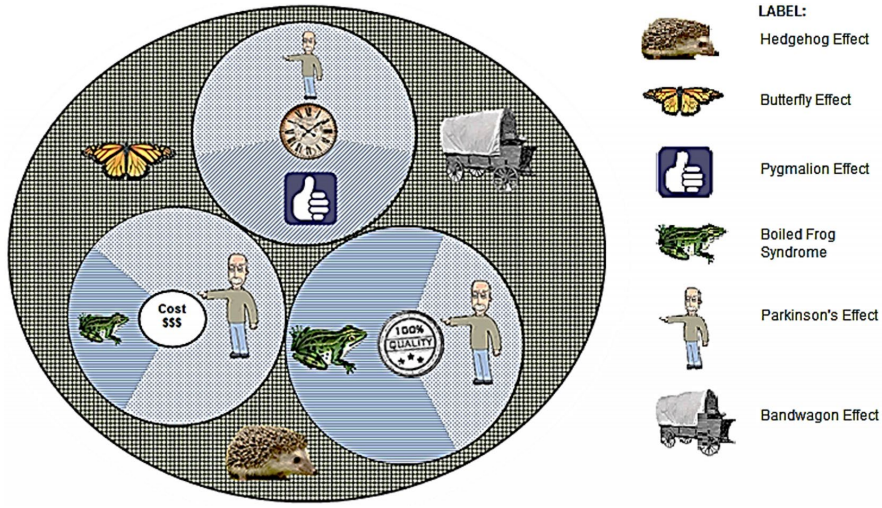


Figure 5. Fuzzy mapping of Psychological Phenomena in time, cost, and quality management

according to the Hedgehog Effect, there is a simultaneous need for closeness and distance in order to create the most effective working environment within the groups or teams; however, project managers with less than six years' working experience did not realize the importance of this effect and prefered closer team relationships. Undeniably, interactions between people will always lead to a Hedgehog Effect (Freud, 1949). According to Pant and Baroudi (2008), the different perceptions reflected in this study may be due to the construction sector involving various parties in a single project, creating an environment where establishing an appropriate distance among team members and a broad range of stakeholders is complex and challenging. It is only construction managers with significant practical experience are able to manage this complexity thus handle or mitigate the potential impacts of the Hedgehog Effect.

Pygmalion Effect states that subordinate performance could be increased by raising leaders' positive expectations towards staff achievement. In this study, however, the interviewees with less than sixteen years working experience did not regard the expression of high expectations as an important alternative source of motivation for project members. Instead, they felt that such high expectations would only make work more stressful. This agrees with the results from Xie and Johns (1995), which shows that the high demands placed on workers leads to stress. However, Xie and Johns (1995) also indicate that individuals possessing significant capability and experience can better manage stress with positive approach, relative to colleagues with less capability and experience; this might explain the relationship revealed in this study regarding Pygmalion Effect and work experience. Also, because of this strong association between Pygmalion Effect and work experience, leaders in the construction project team must cautiously apply the Pygmalion Effect because this psychological phenomenon might not be suitable under all circumstances and has the potential to generate negative outcomes with some staff. As suggested by Patching and Best (2014), ineffectiveness in coping with higher expectations may reduce workers' productivity. This is a very important finding because further fuzzy analysis indicated that the Pygmalion Effect has a direct impact on time management. In context, this could imply that when leaders are able to align their expectations with team members' capability and experience, employees will be more motivated, resulting in improved work efficiency and productivity which lead to an effective time management.

Our results show that the Boiled Frog Syndrome, Parkinson's Law, and Bandwagon Effect were not closely associated with gender and work experience. The negative consequences of the Boiled Frog Syndrome are shown when certain timing is reached and the employees will begin to rebel or quit. All interviewees tend to adhere to lessons from the Boiled Frog Syndrome, regardless of gender and experience. This may be a dangerous situation; according to the results using this fuzzy model, the Boiled Frog Syndrome could impact on both cost and quality of the construction work. When employees tolerate changes while the more senior managers fail to detect any ensuing negative effect, this psychological phenomenon could lead to low productivity and subsequently could herald the possibility of project failure. In addition, the Parkinson's effect was discovered to have a significant impact on three project objectives, time, cost and quality management. Previous research has found a strong relationship between Parkinson's Law and time management, which could be used to explain the impact of Parkinson's effect on cost and quality management. According to Parkinson's Law, team members will be more motivated to complete the construction project when there is a clear and achievable goal and step-by-step activities required to complete the tasks. Through reducing organizational hierarchy, dividing the project into manageable pieces, and setting specific goal and time redundancy at a small number of nodes, managers can ensure that the project is completed on time while mitigating the negative effects of Parkinson's Law. An effective time management prevent unnecessary project losses, resulting in good cost management and, as a result, good quality management.

## Conclusions

This study establishes a fuzzy mapping of project managers to key psychological phenomena with an aim to investigate the relative importance of six psychological phenomena to project management in the construction industry. Fuzzy logic was used to determine the impact of six psychological phenomena on three main goals of project management, namely, time, cost and quality management. All surveyed project managers and experts agreed that six psychological phenomena, namely Hedgehog Effect, Butterfly Effect, Pygmalion Effect, Boiled Frog Syndrome, Parkinson's Effect and Bandwagon Effect, all contribute to the success of project management. After running a fuzzy analysis, however, the experts identified three psychological phenomena as critical to project management. With respect to time management, Pygmalion Effect and Parkinson's Effect are the two most important factors to ensure that the project is finished on time. Boiled Frog Syndrome and Parkinson's Effect are two critical factors in ensuring the effectiveness in cost management and quality management. In a nutshell, the Parkinson's effect should be given managerial attention as it has a direct impact on all project goals, including time, cost and quality. Manager can assign specific and attainable goals to team members and require them to complete the project within a certain time frame. Pygmalion Effect is a powerful tool for motivating team members to perform better; however, it must be used with caution when applied in different situations to avoid the opposite outcome. A good project manager must anticipate potential Boiled Frog Syndrome situation early on and identify any negative changes that could "increase the temperature of the water", taking proactive measures to prevent the unnecessary project losses.

In addition, from the findings of this research, it was found that some psychological facts apply only to specific groups of people, such as project participants from different genders or with varying levels of work experience. The Hedgehog Effect and Pygmalion Effect were both affected by work experience. Males and females respond differently to the Butterfly Effect. With an awareness of these, the project manager could understand better on the project team members based on their demographic information and thus comes out with the most strategic management style to ensure the success of project management. A project manager is critical to the success of any project success. He or she interacts with a wide range of people on a daily basis and thus needs to be equipped with a variety of managerial skills and psychological knowledge to ensure management effectiveness and employees' satisfaction. Knowing the reflections of the psychological phenomena is not enough, project managers must also understand the responses of project participants from different demographic groups towards the six psychological phenomena. The construction industry should raise managers' awareness of the importance of common psychological phenomena on project management by providing manager with access to courses with a psychological component, making appropriate interventions into interpersonal interaction in the workplace, or thinking of ways to provide a psychologically healthy work atmosphere for team members.

The application of psychological principles in construction management is still emerging as an important area of work and research. Humans are a key resource in any construction project; thus, understanding on human's behavior is crucial for project success. Reflections of Psychological Phenomena should be studied widely by construction management professionals to improve their effectiveness. Further research should include a series of case studies. Using a longitudinal and process-oriented approach, researchers will be able to pinpoint what activities can be used to intervene when a psychological effect is determined to be present, and what specific interventions can lead to improved outcomes. This requires more effective observation of project teams over a given period in order to identify the reflections of each psychological phenomenon in construction. Furthermore, these approaches may help to understand how gender and working experience influence the development outcomes relating to these Psychological Phenomena.

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## Author contributions

Yiyi Mo conducted the research and compiled the first draft; Chen Wang and Jeffrey Boon Hui Yap conducted the data analysis; Zhi Wee Guaz contributed to the conceptual development; Yutong Tang and Lincoln C. Wood were in charge of the English usage and editing.

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# APPENDIX

## A: Psychological reflections in construction project management

**Section A:** Demographic Information

Gender: Male Female

Age: 18–23 24–30 31–40 41–50 Above 50

Educational: Degree Master PHD

Position:

Experience in construction industry (Years):

**Section B:** General Overview of Construction Project Management

1. Do you satisfy with the current project management style in the field of construction?
   Very satisfied (1) Satisfied (2) Less satisfied Unsatisfied (3)
2. How well do you understand about the application of psychology in the project management?
   1 (Very understand) 1.5 2 2.5 3 (No idea)
3. Do you think human factor is an important criterion in ensuring the success of a project?
   Yes No

**Section C:** Psychological Phenomena

1. Do you think there is a need to keep some distant between the team members (e.g., distant between leader and his subordinates)?
   Yes No
2. Why do you think so?
   _____ .
3. Do you think that the project success or failure may just due to your small action or decision?
   A. Yes, I realize the importance of any task given to me (even is just small matter).
   B. No, because I do not have such influence as I am not an important character in the project team.
   C. Other (Please specify:_____)
4. When people have high expectation on you, you will most probably feel ……
   A. Motivated
   B. Stressful
   C. Other (Please specify: _____)
5. "Expectation is a good way of motivation".
   How far do you agree with this statement?
   1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)
6. Have you ever encountered the situation where you gain no/less attention from others in any construction project you involved?
   Yes. (Proceed to No. 7)
   No. (Skip No. 7)
7. What is your feeling under this circumstance (no attention is given to you)?
   A. Disappointed
   B. Frustrated
   C. No special feeling
   D. Other (Please specify: _____)
8. Slow and gradual changes (e.g. increase in the workload) are more acceptable where you would not rebel drastically but accept it willingly.
   1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)
9. How will you respond if the changes implemented exceeding your limit of toleration?
   A. Just bear with it.

B. Express your dissatisfaction to the higher level management.

C. Looking for another better job opportunity.

D. Other (Please specify: _____)

10. When there is a goal to be achieved (e.g. fixed time limit for a certain task), you will be more motivated to complete the job.

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

11. Do you think that "pressure" is an essential element in order to push you towards a better achievement in your work?

Yes No

12. With reference to the previous question, why do you think so?

_____ .

13. You feel more comfortable when you are doing the thing which majority people are doing?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

14. Do you voice out your own opinion when you discover that your stand is different from majority team members?

A. Yes, I will say it out.

B. Sometimes

C. No, I will just accept the decision.

15. When most of the people doing the thing in a particular way, it shows that the method is a better approach and if we follow this trend, there will be less tendency to make a mistake. How far do you agree with this statement?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

**B: Psychological reflections in construction project management (Pairwise comparison form)**

**Section A:** Demographic Information

Gender: Male Female

Age: 18–23 24–30 31–40 41–50 Above 50

Educational level: Diploma Degree PHD Master

Current position:

Working in: Public sector Private sector

Working experience in construction industry:

**Section B:** General Overview of Construction Project Management

Please circle the relevant answer.

Do you satisfy with the current project management style in the field of construction?

1 (Very satisfied) 2 3 4 (Not satisfied)

Do you think human factor is an important criterion in ensuring the success of a project?

Yes No

How well do you understand about the application of psychology in the project management? Circle the relevant number.

1 (Very understand) 2 3 4 5(No idea)

**Section C:** Psychological Phenomena

Please circle the relevant answer.

**Hedgehog Effect**

Do you think there is a need for the project team members to keep a distant between each other (eg. boundary between the leader and the subordinates)?

Yes No

With reference to the answer in Question 1, state the reason of your choice.

_____ .

**Butterfly Effect**

Do you agree that any small action or small decision made initially may bring great implications on the project in

subsequent stages?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

Have you ever encountered the situation where the project fail just due to a minor mistake or judgment made initially?

Always Seldom Never

**Pygmalion Effect**

"Expectancy is a good way of motivation".

How effective do you think the power of expectancy in ensuring all the parties involved in the project giving their full commitment?

Very effective Effective Less effective No significant impact

**Boiled Frog Syndrome**

Once there are new changes (e.g., new policy) to be implemented in any construction project, it is better and easier for the parties involved to accept it if the changes are introduced slowly. How far do you agree with this statement?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

**Parkinson's Law**

Setting deadline is a good way to ensure effectiveness. Do you agree with it?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

From your experience, do you think that giving a shorter due date is able to push the parties involved to complete a certain task in a more efficient manner?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

**Bandwagon Effect**

Perception of majority team members brings pressure to leader in making any decision (e.g., It will be difficult to make a decision that against the opinion of most of the members).

(Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

When most of the people doing the thing in a particular way, it shows that the method is a better approach. If we follow this trend, there will be less tendency to make a mistake and it saves the time to seek for a new solution.

How far do you agree with this statement?

1 (Strongly agree) 2 (Agree) 3 (Fairly agree) 4 (Disagree)

**Section D:**

Please rate according to the significance of each psychological phenomena (which phenomenon is more important to take care for the project management).

"1" indicates that the left-hand side phenomenon is absolute important than the right-hand side. "5" indicates that both phenomena are equally important.

"9" indicates that right hand side phenomenon is absolute important than left hand side.

With respect to the overall goal "good project management"

Q1. How important is "Time" when it is compared to "Cost"?

Q2. How important is "Time" when it is compared to "Quality"?

Q3. How important is "Cost" when it is compared to "Quality"?

| With respect to: Good project management | | Importance (or preference) of one main-attribute over another | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Absolute | Very Strong | Fairly strong | Weak | Equal | Weak | Fairly strong | Very strong | Absolute | |
| Q1 | Time | | | | | | | | | | Cost |
| Q2 | Time | | | | | | | | | | Quality |
| Q3 | Cost | | | | | | | | | | Quality |

For the following questions, please kindly refer to the description below about the psychological phenomena in order to answer.

**Hedgehog effect:**

Keeping optimum distant between team members

**Butterfly effect:**

Small changes or decision in the initial stage can cause a huge impact in the end (either cause the project success or fail)

**Pygmalion effect:**

Expectation on people can bring influence on the performance of that person.

**Boiled frog syndrome:**

Failing to detect any changes in the working environment (in long term) will lead to organisation failure because the team members could not tolerate anymore.

**Parkinson's effect:**

Work expands so as to fill the time available for its completion (eg. People tend to complete the work only when the deadline reached)

**Bandwagon effect:**

People tend to follow majority without proper examination on that particular issue.

With respect to main attribute "Time management"

Q4. How significant is "Hedgehog effect" when it is compared to "Butterfly effect"?
Q5. How significant is "Hedgehog effect" when it is compared to "Pygmalion effect"?
Q6. How significant is "Hedgehog effect" when it is compared to "Boiled frog syndrome"?
Q7. How significant is "Hedgehog effect" when it is compared to "Parkinson effect"?
Q8. How significant is "Hedgehog effect" when it is compared to "Bandwagon effect"?
Q9. How significant is "Butterfly effect" when it is compared to "Pygmalion effect"?
Q10. How significant is "Butterfly effect" when it is compared to "Boiled frog syndrome"?
Q11. How significant is "Butterfly effect" when it is compared to "Parkinson effect"?
Q12. How significant is "Butterfly effect" when it is compared to "Bandwagon effect"?
Q13. How significant is "Pygmalion effect" when it is compared to "Boiled frog syndrome"?
Q14. How significant is "Pygmalion effect" when it is compared to "Parkinson effect"?
Q15. How significant is "Pygmalion effect" when it is compared to "Bandwagon effect"?
Q16. How significant is "Boiled frog syndrome" when it is compared to "Parkinson effect"?
Q17. How significant is "Boiled frog syndrome" when it is compared to "Bandwagon effect"?
Q18. How significant is "Parkinson effect" when it is compared to "Bandwagon effect"?

| With respect to: Time management | | Importance (or preference) of one main-attribute over another | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Absolute | Very Strong | Fairly strong | Weak | Equal | Weak | Fairly strong | Very strong | Absolute | |
| Q4 | Hedgehog | | | | | | | | | | Butterfly |
| Q5 | Hedgehog | | | | | | | | | | Pygmalion |
| Q6 | Hedgehog | | | | | | | | | | Frog |
| Q7 | Hedgehog | | | | | | | | | | Parkinson |
| Q8 | Hedgehog | | | | | | | | | | Bandwagon |
| Q9 | Butterfly | | | | | | | | | | Pygmalion |
| Q10 | Butterfly | | | | | | | | | | Frog |
| Q11 | Butterfly | | | | | | | | | | Parkinson |
| Q12 | Butterfly | | | | | | | | | | Bandwagon |
| Q13 | Pygmalion | | | | | | | | | | Frog |
| Q14 | Pygmalion | | | | | | | | | | Parkinson |
| Q15 | Pygmalion | | | | | | | | | | Bandwagon |
| Q16 | Frog | | | | | | | | | | Parkinson |
| Q17 | Frog | | | | | | | | | | Bandwagon |
| Q18 | Parkinson | | | | | | | | | | Bandwagon |

With respect to main attribute "Cost management"
Q19. How significant is "Hedgehog effect" when it is compared to "Butterfly effect"?
Q20. How significant is "Hedgehog effect" when it is compared to "Pygmalion effect"?
Q21. How significant is "Hedgehog effect" when it is compared to "Boiled frog syndrome"?
Q22. How significant is "Hedgehog effect" when it is compared to "Parkinson effect"?
Q23. How significant is "Hedgehog effect" when it is compared to "Bandwagon effect"?
Q24. How significant is "Butterfly effect" when it is compared to "Pygmalion effect"?
Q25. How significant is "Butterfly effect" when it is compared to "Boiled frog syndrome"?
Q26. How significant is "Butterfly effect" when it is compared to "Parkinson effect"?
Q27. How significant is "Butterfly effect" when it is compared to "Bandwagon effect"?
Q28. How significant is "Pygmalion effect" when it is compared to "Boiled frog syndrome"?
Q29. How significant is "Pygmalion effect" when it is compared to "Parkinson effect"?
Q30. How significant is "Pygmalion effect" when it is compared to "Bandwagon effect"?
Q31. How significant is "Boiled frog syndrome" when it is compared to "Parkinson effect"?
Q32. How significant is "Boiled frog syndrome" when it is compared to "Bandwagon effect"?
Q33. How significant is "Parkinson effect" when it is compared to "Bandwagon effect"?

| With respect to: Cost management | | Importance (or preference) of one main-attribute over another | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Absolute | Very Strong | Fairly strong | Weak | Equal | Weak | Fairly strong | Very strong | Absolute | |
| Q19 | Hedgehog | | | | | | | | | | Butterfly |
| Q20 | Hedgehog | | | | | | | | | | Pygmalion |
| Q21 | Hedgehog | | | | | | | | | | Frog |
| Q22 | Hedgehog | | | | | | | | | | Parkinson |
| Q23 | Hedgehog | | | | | | | | | | Bandwagon |
| Q24 | Butterfly | | | | | | | | | | Pygmalion |
| Q25 | Butterfly | | | | | | | | | | Frog |
| Q26 | Butterfly | | | | | | | | | | Parkinson |
| Q27 | Butterfly | | | | | | | | | | Bandwagon |
| Q28 | Pygmalion | | | | | | | | | | Frog |
| Q29 | Pygmalion | | | | | | | | | | Parkinson |
| Q30 | Pygmalion | | | | | | | | | | Bandwagon |
| Q31 | Frog | | | | | | | | | | Parkinson |
| Q32 | Frog | | | | | | | | | | Bandwagon |
| Q33 | Parkinson | | | | | | | | | | Bandwagon |

With respect to main attribute "Quality management"
Q34. How significant is "Hedgehog effect" when it is compared to "Butterfly effect"?
Q35. How significant is "Hedgehog effect" when it is compared to "Pygmalion effect"?
Q36. How significant is "Hedgehog effect" when it is compared to "Boiled frog syndrome"?
Q37. How significant is "Hedgehog effect" when it is compared to "Parkinson effect"?
Q38. How significant is "Hedgehog effect" when it is compared to "Bandwagon effect"?
Q39. How significant is "Butterfly effect" when it is compared to "Pygmalion effect"?
Q40. How significant is "Butterfly effect" when it is compared to "Boiled frog syndrome"?
Q41. How significant is "Butterfly effect" when it is compared to "Parkinson effect"?
Q42. How significant is "Butterfly effect" when it is compared to "Bandwagon effect"?
Q43. How significant is "Pygmalion effect" when it is compared to "Boiled frog syndrome"?
Q44. How significant is "Pygmalion effect" when it is compared to "Parkinson effect"?
Q45. How significant is "Pygmalion effect" when it is compared to "Bandwagon effect"?

Q46. How significant is “Boiled frog syndrome” when it is compared to “Parkinson effect”?
Q47. How significant is “Boiled frog syndrome” when it is compared to “Bandwagon effect”?
Q48. How significant is “Parkinson effect” when it is compared to “Bandwagon effect”?

| With respect to: Quality management | | Importance (or preference) of one main-attribute over another | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Absolute | Very Strong | Fairly strong | Weak | Equal | Weak | Fairly strong | Very strong | Absolute | |
| Q34 | Hedgehog | | | | | | | | | | Butterfly |
| Q35 | Hedgehog | | | | | | | | | | Pygmalion |
| Q36 | Hedgehog | | | | | | | | | | Frog |
| Q37 | Hedgehog | | | | | | | | | | Parkinson |
| Q38 | Hedgehog | | | | | | | | | | Bandwagon |
| Q39 | Butterfly | | | | | | | | | | Pygmalion |
| Q40 | Butterfly | | | | | | | | | | Frog |
| Q41 | Butterfly | | | | | | | | | | Parkinson |
| Q42 | Butterfly | | | | | | | | | | Bandwagon |
| Q43 | Pygmalion | | | | | | | | | | Frog |
| Q44 | Pygmalion | | | | | | | | | | Parkinson |
| Q45 | Pygmalion | | | | | | | | | | Bandwagon |
| Q46 | Frog | | | | | | | | | | Parkinson |
| Q47 | Frog | | | | | | | | | | Bandwagon |
| Q48 | Parkinson | | | | | | | | | | Bandwagon |