ISM Model of Critical Success Factors of Using Alternative Dispute Solutions on Saudi Arabian Construction Projects

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Abstract

This paper discusses the Interpretive Structural Modelling (ISM) approach as a tool in the pyramid chart categories and the critical success factors of using alternative dispute solutions on Saudi Arabian construction projects. By defining the relationships, and investigating the interrelationships between the eleven important progressing critical success factors and MICMAC analysis, an advantageous tool for allowing practitioners to understand the critical factors of success in the alternative dispute solutions of construction projects that can be created. It can be stated here that the main aim of this study is to develop a model of critical success factors for alternative dispute solutions, thus serving to analyse the interaction of the major critical success factors, and helping to improve dispute resolutions in Saudi Arabian construction projects.

Keywords:

Ism, Disputes, Construction, Csf, Ksa.

ملخص

هذه الورقة تناقش نهج النمذجة الهيكلية التفسيرية (ISMكأداة فى فئات الرسم البيانى الهرمى وعوامل النجاح الحاسمة لاستخدام بدائل حلول النزاعات فى مشاريع البناء والتشييد الهندسية فى المملكة العربية السعودية من خلال أولا تحديد العلاقات بين عوامل النجاح والتحقيق فى العلاقات المتبادلة بين أحد عشر عامل نجاح حرجة تم عرضها وتقديمها من خلال نظام MICMAC ، حيث يمكن إنشاء أداة مفيدة للسماح للممارسين لفهم العوامل الحاسمة للنجاح فى بدائل حلول النزاعات فى مشاريع البناء والتشييد الهندسية فى المملكة العربية السعودية. حيث يمكن أن نذكر هنا أن الهدف الرئيسى من هذه الدراسة هو تطوير نموذج لعوامل النجاح الحاسمة لبدائل حلول النزاعات فى مشاريع التشييد والبناء الهندسية ، حيث يمكننا ذلك من العمل على تحليل العلاقات بين عوامل النجاح الحاسمة الرئيسية ، وكذلك المساعدة على تحسين طرق حلول النزاعات فى التشييد والبناء فى المشاريع الهندسية فى المملكة العربية السعودية.

ISM والذى يمكن اعتباره إطارًا نظريًا مبدئيًا ، حيث أنه يشتمل على الطريقة التى يفهمها خبراء الموضوع ويشرحون ظاهرة الدراسة تعد ISM أداة مفيدة للتمثيل الرسمى لمشكلة قائمة على القرار ، من حيث تستخدم مفاهيم نظرية الرسم البيانى والمصفوفة. علاوة على ذلك، أن تحليل MICMAC يستخدم على نطاق واسع كوسيلة لتحديد وتحليل المتغيرات التى تعد لقوة الاعتماد وقوة القيادة؛ حيث الهدف من MICMAC هو جعل تحليل قوة السائق (المؤثر) و

قوة الاعتماد على العوامل التى تهم العديد من الدراسات نهج ISM فى الماضى

استخدم أسلوب ISM لمعرفة العلاقات المتبادلة بين العناصر المختلفة المرتبطة بمشكلة معينة. على العكس استخدم ISM لمعرفة وتحليل العوامل الحاسمة التى تؤثر على الامتثال للمعايير ومستوى تأثيرها فى صناعة الأغذية فى العالم النامى

الكلمات المفتاحية:

التشييد، حلول النزاعات، البناء ,ISM، المملكة العربية السعودية، المشاريع الهندسية

Introduction

In 1973, Warfield proposed the ISM-based approach which can be considered as a tentative theoretical framework, in that it encapsulates the way that subject matter experts understand and explain the phenomenon of study (Warfield, 1974). ISM is also useful in that it can summarize and find relationships amongst specific variables, thus defining an issue or problem (Sage, 1977). According to Von Winterfeldt (1980), ISM is a useful tool for the formal representation of a decision-based problem, in that it employs graph and matrix theory notions. Furthermore, Saxena and Vrat (1990) observe that MICMAC analysis is utilized extensively as a way of identifying and analysing variables in accordance to their dependence power and driving power; where the aim of MICMAC is to make analyse driver (influencer) power, and dependence (reliance) power of the factors involved (Mandal and Deshmukh,.)1994

Numerous studies have utilised the ISM approach in the past. Nishat et al. (2006) used the ISM method to find out the interrelationships found between various elements linked to a particular problem. Conversely, (2009) and Sagheer et al. (2009) utilised ISM to find out and analyse the critical factors that affect standards compliance and their level of effect in the developing world's food industry. Manoharan et al. (2010) employed ISM to analyse the interrelationships of factors of performance appraisal, and to further plan a training programme for employees. ISM was further deployed by Lin et al. (2011) in order to understand the causal interrelationships of a vendor performance evaluation framework. Overall, perhaps the merit and wide use of the ISM process can be seen in that it transforms poorly articulated and unclear system mental models, into well-defined and visible models that can be utilised for various purposes (Mishra et al., 2012)

ISM Methodology

Interpretive Structural Modelling (ISM) is a methodological approach to identification of the various elements underlying a problem, or any variables related to an issue, and then using a group-solving technique to develop such elements. Accordingly, there are eleven critical success factors determined for ADR, where the interaction amongst these factors are analysed using ISM. Based on the dependency or driving level of factors and utilising the MICMAC technique, the factors can be further classified into four areas; dependent, autonomous, driving and linage. Thus, ISM is a modelling technique whereby a diagraph model is used to portray the overall structure and specific variable relationships for the system under consideration. As such, the ISM method can be utilised to employ a process of logical and systematic thinking in the approach of a complex issue, and then communicating the results of the said process to others (Malone, 1975). Thus, this methodology is suitable for use by professionals or academics that are conversant with the challenge or problem's context (Agarwal et al., 2007.(

The tool of the Interpretive Structural Modelling (ISM) approach is discussed throughout this chapter, in relation to the categories of the pyramid chart, with an analysis of critical success factors that present potential variations to dispute solutions in regards to construction projects in KSA. The tool becomes advantageous in allowing practitioners to comprehend the critical success factors for alternative disputes resolution in construction projects, as the relationships become defined, while the eleven critical success factors for ADR and MICMAC analysis are evaluated.

Following on from this, the main aim of this research hopes to advance a model of critical success factors that present solutions for alternative disputes, and thus, present an analysis of the interaction between the substantial factors, and assist in improving construction projects and their dispute resolutions within Saudi Arabia. Nevertheless, there are drawbacks to the ISM methodology, as the variables can often be judged by an individual, which may lead towards an element of subjectivity. Indeed, the variables and their perception depend on individual comprehension of the organisation, as well as familiarity with how it operates, which can affect the model due to bias (Kannan and Haq, 2007.(

CSF Model Development

When developing the critical success factor (CSF) model for alternative dispute resolution in Saudi Arabian construction projects, by using ISM, Sharma (2013) notes that a number of stages should be followed. These are:

•Finding what factors that are related to the problem. This could be completed through the distribution of surveys or by employing a group problem solving technique.

•Forming a contextual relationship between factors in the sense of which pair of factors could be examined.

•Developing a structural self-interaction matrix (SSIM) of the factors, which will serve to reveal the pair-wise relationship amongst system factors (this matrix is subsequently checked for transitivity.

•Developing a reachability matrix from the results of the SSIM.

•Partitioning the reachability matrix into diverse levels.

•Converting the reachability matrix into a conical form.

•Drawing a diagraph based on the relationship indicated in the reachability matrix and removes any transitive connections.

•Converting the resultant diagraph into a model based on ISM, by using the statements instead of factor nodes.

•Check the model in order to find out any conceptual inconsistencies and make necessary adjustments.

The next sections illustrated below will depict the actual levels that develop a CSF model by ISM.

Structural Self-Interactive Matrix (SSIM)

Accordingly, a Structural Self-Interactive Matrix (SSIM) table for analysing the contextual relationship between the 11 critical success factors for ADR can be drawn. This matrix signifies of how the relationship is directed between two factors (i, which is placed on the horizontal axis and j which is placed on the vertical axis) by a pairwise comparison of factors. It is for this reason that the symbols V, A, X and O were used. The symbol of V represents the relation from factor i to factor j; if the factor i affects on or reaches to the j factor. The symbol A represents the relation from factor j to factor i; if factor j reaches to factor i. The symbol X represents a relationship in both directions; if the factors i and j reach each other. Finally, the symbol O represents no relationship between the two factors; if factors i and j are unrelated. As Warfield (1974) implied that the optimum group number would be between 5 and 10 respondents, the basis of the SSIM came from questions asked to 13 academics, experts and arbitrators. Table 7.1 depicts the structural self-interaction matrix.

TABLE 1: STRUCTURAL SELF-INTERACTION MATRIX (SSIM).

No		1	2	3	4	5	6	7	8	9	10	11
		Speed	Economy	Flexibility	Privacy	laintaining Relationship	Confidence	Neutraility	Fairness	Psychological	Reputation	Non-advirsal
1	Speed	x	v	v	o	v	v	o	v	v	o	o
2	Economy	A	x	v	o	v	v	o	o	o	o	o
3	Flexibility	A	A	x	o	v	v	o	O	x	o	o
4	Privacy	O	O	O	x	A	A	O	O	A	v	o
5	ning Relati	A	A	A	V	x	A	A	A	X	x	v
6	Confidence	O	A	A	V	V	x	V	V	A	v	v
7	Neutraility	O	O	O	O	V	A	x	V	V	o	o
8	Fairness	A	O	O	O	V	A	A	X	V	o	v
9	sychologica	A	O	A	X	A	X	A	A	x	v	v
10	Reputation	O	O	O	A	X	A	O	O	V	x	x
11	lon-advirsa	O	O	O	O	A	A	O	A	A	x	x

Initial Reachability Matrix (IR)

After the completion of the Structural Self-Interaction Matrix (SSIM), the results into a Reachability Matrix (RM), by substituting the factors V, A, X and O by 1 or of the substitution of 1s and 0s are as follows:

If the i and j entry in the Structural Self-Interaction Matrix (SSIM) is V, then the i reachability matrix will be 1 and the j and i entry is 0.

If the i and j entry in the Structural Self-Interaction Matrix (SSIM) is A, then the i reachability matrix will be 0 and the j and i entry is 1.

If the i and j entry in the Structural Self-Interaction Matrix (SSIM) is X, then the i reachability matrix will be 1 and the j and i entry is 1.

If the i and j entry in the Structural Self-Interaction Matrix (SSIM) is O, then the i reachability matrix will be 0 and the j and i entry is 0. The initial reachability matrix for the critical success factors is depicted in Table 2.

TABLE 2: INITIAL REACHABILITY MATRIX

No		1	2	3	4	5	6	7	8	9	10	11	
		Speed	Economy	Flexibility	Privacy	laintaining Relationship	Confidence	Neutraility	Fairness	Psychological	Reputation	Non-advirsal	Driving Power
1	Speed	1	1	1	0	1	1	0	1	1	0	0	7
2	Economy	0	1	1	0	1	1	0	0	0	0	0	4
3	Flexibility	0	0	1	0	1	1	0	0	1	0	0	4
4	Privacy	0	0	0	1	0	0	0	0	1	1	0	3
5	ining Relatio	0	0	0	1	1	0	0	0	1	1	1	5
6	Confidence	0	0	0	1	1	1	1	1	1	1	1	8
7	Neutraility	0	0	0	0	1	0	1	1	1	0	0	4
8	Fairness	0	0	0	0	1	0	0	1	1	0	1	4
9	Psychologica	0	0	1	1	1	1	0	0	1	1	1	7
10	Reputation	0	0	0	0	1	0	0	0	0	1	1	3
11	Non-advirsal	0	0	0	0	0	0	0	0	0	1	1	2
	Dependence Po	1	2	4	4	9	5	2	4	8	6	6	

Level Partitions

Warfield (1974) indicates that the reachability and antecedent set of each variable can be found in the final reachability matrix. Accordingly, a particular variable's 'reachability set' is constructed of the variable itself and the other variables that it may help achieve. This is also the case for the 'antecedent set', and subsequently, the intersection of these two sets is derived

for all variables. The top-level position in the ISM hierarchy is given to the variable that has the same reachability and intersection sets, as these will not be useful in achieving any alternate variable that is above their own level. Thus, after identifying the top-level factor, this can be disregarded in relation to the remaining variables. From the first iteration table (3), it can be seen that factors 10 and 11 are found at level 1, and thus these are positioned at the top of the ISM model, before being discarded from the other remaining factors, and the iterative procedure is thus continued until iteration 9 (Table 11).

TABLE 3: ITERATION 1.

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3,5,6,8,9	1	1	
2	Economy	2,3,5,6	1,2	2	
3	Flexibility	3,5,6,9	1,2,3,9	3	
4	Privacy	4,9,10	4,5,6,9	4,9	
5	Maintaining Relationships	4,5,9,10,,11	1.2.3.5.6.7.8,9.10	4,9,10	
6	Confidence	4.5.6.7.8,9,10,11	1,2,3,6,9	6,9	
7	Neutraility	5,7,8,9	6,7	7	
8	Fairness	5,8,9,11	1,6,7,8	8	
9	Psychological	3,4,5,6,9,10,11	1,3,4,,5,6,7,8,9	3,4,5,6,9	
10	Reputation	5,10,11	4,5,6,9,10,11	5,10,11	1
11	Non-advirsal	10,11	5,6,8,9.10,11	10,11	1

TABLE 4: ITERATION 2.

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3,5,6,8,9	1	1	
2	Economy	2,3,5,6	1,2	2	
3	Flexibility	3,5,6,9	1,2,3,9	3	
4	Privacy	4,9	4,5,6,9	4,9	2
5	Maintaining Relationships	4,5,9	1.2.3.5.6.7.8,9	4,9	
6	Confidence	4.5.6.7.8,9	1,2,3,6,9	6,9	
7	Neutraility	5,7,8,9	6,7	7	
8	Fairness	5,8,9	1,6,7,8	8	
9	Psychological	3,4,5,6,9	1,3,4,,5,6,7,8,9	3,4,5,6,9	2

TABLE 5: ITERATION 3.

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3,5,6,8	1	1	
2	Economy	2,3,5,6	1,2	2	
3	Flexibility	3,5,6	1,2,3	3	
5	Maintaining Relationships	5	1.2.3.5.6.7.8	5	3
6	Confidence	5.6.7.8	1,2,3,6	6	
7	Neutraility	5,7,8	6,7	7	
8	Fairness	5,8	1,6,7,8	8	

TABLE 6: ITERATION 4.

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3,6,8	1	1	
2	Economy	2,3,6	1,2	2	
3	Flexibility	3,6	1,2,3	3	
6	Confidence	6.7.8	1,2,3,6	6	
7	Neutraility	7,8	6,7	7	
8	Fairness	8	1,6,7,8	8	4

TABLE ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT.**: ITERATION 5**

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3,6	1	1	
2	Economy	2,3,6	1,2	2	
3	Flexibility	3,6	1,2,3	3	
6	Confidence	6.7	1,2,3,6	6	
7	Neutraility	7	6,7	7	5

TABLE 8: ITERATION 6.

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3,6	1	1	
2	Economy	2,3,6	1,2	2	
3	Flexibility	3,6	1,2,3	3	
6	Confidence	6	1,2,3,6	6	6

Table 9: Iteration 7

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2,3	1	1	
2	Economy	2,3	1,2	2	
3	Flexibility	3	1,2,3	3	7

Table 10: Iteration 8

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1,2	1	1	
2	Economy	2	1,2	2	8

Table 11: Iteration 9

	Factors	reachability set	AntecedentsetIntersect	Intersection set	Level
1	Speed	1	1	1	9

Conical Matrix

The creation of a conical matrix is built on the basis of the partitioned reachability matrix. This is done by rearranging the factors according to their levels, which means that factors possessing the same levels are clustered together. Doing so serves to determine the drive power and dependence power ranking.

ISM Model

This model contributed in understanding the relationship between critical successful factors for alternative dispute resolution in construction projects. There was number of critical successful factors carrying more importance comparing to the others. The advantage of clearly understanding the relationship and connection between these factors will help the concerned entities and ministries and also scholarships, arbitrators, experts and other who are concerned. This model was developed through interviewing 13 academics, arbitrators and experts.

They were asked about eleven successful factors that connect their common relationship. The sample consists of nine levels which are illustrated in the figure 7.1, Starting from the bottom level (9) refers to the speed factor as it is an important factor and determines selection of alternative dispute resolution based on timing. Negotiation method was the fastest method to resolve disputes because the time factor affects the next factor, level (8), which is economic factor. Since expenditure is a key consideration for parties involved in disputes, the method of dispute resolution which is least expensive will typically encourage parties in the dispute to select this method due to its cost. Expenditure also has an effect on the next level, which is the flexibility factor, and is denoted by level (7) on the figure. This factor is important for selecting a solution for disputes, since flexibility can play a role in influencing factors, such as time and place according to the experts' and arbitrators' opinion. With this method, the parties in the dispute, as well as the arbitrators, may come to an agreement at any time (during the day or night) or at any other time during official working hours, and also in any place other than official places, such as in the hotel lobby/waiting area, or in an office. Flexibility factor will affect the next level on the list, which is level (6) and refers to the trust factor. The trust factor is crucial to all parties involved in the dispute, as selecting a method of dispute resolution is not achieved by trust, since trust is achieved through reputation factor, which is built or developed based on any previous dealings that have occurred between parties. The trust factor also affects the next factor (level 5), which is neutrality factor. Neutrality is considered to be very important to some parties and may therefore be selected, as this may be instrumental in achieving a solution to some disputes, particularly when there are an odd number of arbitrators involved (method of arbitration and DAB). Neutrality factor affects the next level, which is fairness (level 4), which ensures that any verdicts or decisions made, even in the case of a loss or a decision against one party is judicious. Being fair also affects the next factor, which is level 3, and that is relation preservation factor. Relation preservation factor is an important factor for all parties and arbitrators because in some instances, solutions for disputes can cause enmity after being implemented; however, some solutions, in contrast, can cause good relationship between parties after being implemented. The relation preservation factor can have an impact on the next two factors, which are the psychosocial and privacy factors. In order to create a good relationship, privacy should be protected and good spirit should be developed and preserved in order to have a good relationship.

The second level factors in the list are the privacy and psychosocial factors, and are also important as having a mutual relationship means having to work to preserve privacy and have a good psychosocial factor. This also works in reverse, as having a good psychosocial factor can be achieved through privacy. The psychosocial factor also impacts on reputation and non-adversarial factors, both of which are the first level factors in the figure. The arrow linking/between these two illustrate how they can have an effect on each other. If no enmity

exists between the parties involved in the dispute, their reputations will get better and after some time, due to their reputations getting better, there should, in theory, be no dispute left.

Due to the mutual relationship among various factors based on the matrix of the final relation tools, a structural model can be developed. The arrow indicates that if there is a relationship between i to j, variables can illustrate them. The arrows that are pointing from 9 to 1 are all pointing in the same direction. Additionally, the arrows at levels 2 to 1 are also going in the same direction, an indication that two factors at both levels (two and one) have strong ties. Speed, economic and flexibility factors have a big impact on selecting the most suitable dispute resolution method in construction projects in Saudi Arabia, but it is worth mentioning that some classical solutions for solving disputes in the state and private sector do not rely on the factors of time, expenditure and flexibility. Following these factors, in terms of importance are trust, neutrality, and relation preservation. Due to their importance, these factors should be considered by decision makers in dispute solutions. Finally, the last of the factors listed are psychosocial, privacy, reputation and non-adversarial. The significance of these factors cannot be said to be any less important than the others in improving dispute resolution in construction projects in KSA.

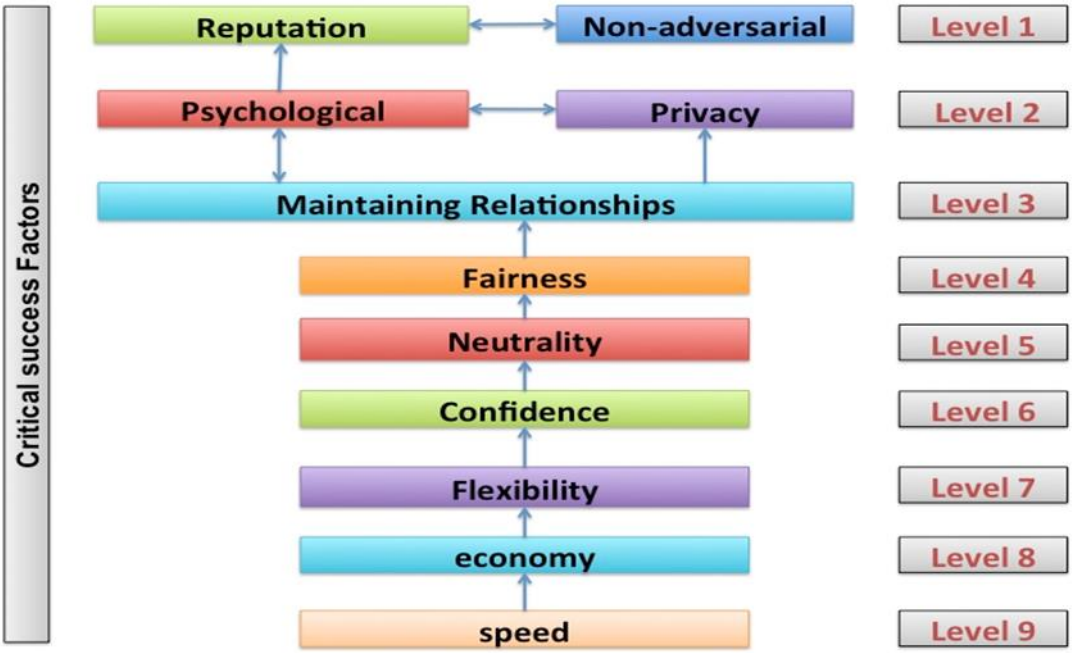

FIGURE 1: ISM MODEL.

Classification of Factors Using MICMAC Analysis

The ISM model and following MICMAC analysis identified the hierarchical structure and degree of interrelationship between success factors for ADR. The aim of the cross-impact matrix multiplication applied to classification, known as MICMAC, is to provide an analysis of the dependence power and drive power of factors, as shown in Table 7.12. The principle of analysis is based on the multiplication properties of matrices. The barriers can be classified into a further four groups based on the driving power and dependence power, (Attri *et al*., 2013). These are:

1. Autonomous Factors are the factors that possess both weak drive power and weak dependence power.
2. Linkage factors are the factors that possess both strong drive power and strong dependence power.
3. Dependent Factors are the factors that possess weak drive power and strong dependence power.
4. Independent Factors are the factors that possess strong drive power and weak dependence power.

Every measure of performance has been placed into four individual factors that are based upon the driving power and dependence they possess (see Table 7-12). These factors are shown as: 1) speed, which is denoted by 7 for driving power and 1 for dependence power, and thus is placed in the fourth group of independent factors; 2) economy, which is denoted by 4 as the driving power and 2 for dependence, and as a result means that it is positioned in the first group; 3) flexibility, which is denoted by 4 as the driving power and the dependence power;
4) privacy, which is denoted by 3 as the driving power, with 4 as the dependence power. Additionally, the variables' dependence and driver power were analysed by MICMAC analysis, and the drivers were classified into four groups (see Figure 7.2) as follows:

• The autonomous factors represent the first group, which are comprised of weak driving power and weak dependence power, which equates to minimal driving power and dependence; privacy as factor 4; flexibility, fairness as factors 3 and 8, which act as linkage factors; and economy and neutrality as factors 2 and 7, which act as independent factors. Moreover, the autonomous factors may also function as a secondary variable.

• The dependent factors are the second group, which are dependent measures that are denoted by weak driving power, together with strong dependence power. This includes dependent measures: reputation (factor 10) and non-adversarial (factor 11).

• Linkage factors comprised the third group, which have strong driving and dependence power. These include confidence as factor 6; and psychological factors as factor 9. These measures and their subsequent action will result in affecting the other measures.

• Independent factors comprise the fourth group, which are made up of strong driving power, yet have weak dependence. These include speed as a factor.

TABLE 12: DRIVING POWER AND DEPENDENT POWER FOR ELEMENTS.

No.	Factors	Driving Power	Dependent Power
1	Speed	7	1
2	Economy	4	2
3	Flexibility	4	4
4	Privacy	3	4
5	Maintaining relationship	5	9
6	Confidence	8	5
7	Neutrality	4	2
8	Fairness	4	4
9	Psychological	7	8
10	Reputations	3	6
11	Non-Adversarial	2	6

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F1</td><td rowspan="2"></td><td></td><td colspan="4" rowspan="4">Linkage Factors
F9</td></tr>
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<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
</table>

Figure 7-2: Classification factors (MICMAC Analysis).

Summary

This chapter sought to develop the critical success factors for an ADR model in Saudi construction projects by investigating the hierarchical structure and interrelationships of the factors. ISM methodology and MICMAC analysis were adopted to develop the hierarchical structure and explore the relationship model among the critical success factors to improve dispute resolution. The present ISM model can help dispute resolution in Saudi Arabian construction projects through understanding the interaction of 11 critical success factors affecting alternative dispute resolutions, and assist in providing decision makers with a realistic picture to deal with disputes and resolutions in Saudi construction projects.

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