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PREFABRICATION IN A SOUTH AFRICAN METROPOLE

Smallwood, J*, Panter, J, and Emuze, F
Department of Construction Management, Nelson Mandela University, South Africa
* john.smallwood@mandela.ac.za

Abstract: The adoption of prefabrication in many developing countries, including South Africa, remains slow. The aim of the study was to determine why the adoption of prefabrication in South African construction has been slow, and to evolve a framework of interventions to promote the adoption thereof. An online quantitative study was conducted among a range of built environment practitioners in the Nelson Mandela Bay metropole. Key findings include: quality, schedule, and cost predominate in terms of the benefits of prefabrication; limitation of design changes, the need for early constructability information, and increased upfront capital costs predominate in terms of the constraints to prefabrication, and there is potential for and a need for increased prefabrication. Conclusions include: prefabrication is not pervasive; there is an 'appetite' for prefabrication; increased usage is dependent upon the availability of prefabricated systems and elements, designers' willingness to adopt them, and designers' willingness to engender prefabrication through design; there is a valid case for prefabrication, especially with respect to quality, but also schedule, on site work, and cost; there are challenges in terms of the adoption of prefabricated systems and elements, however, they are not insurmountable, and there is potential to increase prefabrication due to the resulting benefits. In terms of recommendations, five categories of interventions were evolved to promote the adoption of prefabrication, namely information, awareness, design, competency, and manufacturers.

Keywords: Benefits; Constraints; Construction; Prefabrication

1 INTRODUCTION

According to Lakhani (2024), "Prefabrication is a term used for when components for a building are made off-site and assembled on-site."

The challenge with respect to prefabrication is that despite the benefits thereof, its adoption in many developing countries, including South Africa, remains slow (Aigbavboa et al., 2018). Furthermore, limited studies have been conducted relative to prefabrication in South African construction, and there is a paucity of related literature (Aigbavboa *et al.*, 2018), which constitutes the research gap.

The aim of the study was to determine why the adoption of prefabrication in South African construction has been slow, and to evolve a framework of interventions to promote the adoption thereof. The objectives of the study were to determine the:

- extent to which prefabrication is used in the Nelson Mandela Bay metropole;
- benefits of prefabrication, and
- constraints of prefabrication.

2 LITERATURE REVIEW

2.1 Benefits of Prefabrication

Aigbavboa *et al.* (2018) cite the benefits of prefabrication as increased design flexibility, simplified construction methods, a reduction of onsite labour, reduced construction time, and cost savings. Lakhani (2024) in turn contends that prefabricated construction reduces on-site time, improves quality, and lowers overall costs, compared to traditional construction methods.

According to Baghchesaraei *et al.* (2015), prefabrication systems have the potential for increased use due to their inherent characteristics. These include programme, as activities progress off and on site in parallel. Factory tolerances and workmanship, which enhance quality due to consistency of activities. Energy consumption is reduced due to automation. Labour costs are less due to factory-based systems. Programme certainty due to automation, computerisation, repetition, and a controlled environment. Health and safety (H&S) is enhanced due to a controlled environment. Rocha *et al.* (2023) refer to the potential of prefabrication in terms of increases in productivity, cost reduction, and the rigour of enhanced quality control. Khahro *et al.* (2019) cite an array of benefits: enhanced planning and design; elimination of on-site problems, meteorological factors, and subcontractor scheduling delays; faster manufacturing; shorter construction time; enhanced monitoring with respect to the environment; improved quality and sustainability; mitigation of the causes of construction waste that arise during design and construction, reduced total construction costs, and better aesthetic prospects.

2.2 Barriers with respect to prefabrication

Baghchesaraei *et al.* (2015) attribute the limited use of prefabrication in developing countries to a lack of knowledge and experience. However, they add that developing countries have been importing knowledge and techniques, and prefabrication technologies are playing an important role in multiple developing countries, and its prevalence has increased. Based upon a study conducted in Australia, Zhang et al. (2022) identified challenges classified into eight aspects related to feasibility, design, manufacturing, transportation, on-site construction, standardisation, skills and knowledge, finance, and market.

Rocha *et al.* (2023) refer to the impact associated with transportation costs as prefabrication systems require an extra initial phase in relation to transportation from the factory to the site, loading and unloading, and then related H&S costs, which can represent up to 20% of the total impact. They point out that these costs are amplified in the case of modular construction as these issues may limit the size and weight of modules, and the mode of transport.

2.3 Promoting the adoption of prefabrication

Zhang et al. (2022) identified 21 recommendations and related key responsible parties, to address the eight aspects in terms of challenges with respect to prefabrication. Awareness-related interventions include: exhibitions, offline and online events and media reports; trade shows, and lobbying financial institutions. In terms of design: early collaboration during the design process; providing more test results in related standards, and adequate planning of lifting operations and lifting design. Manufacturing-related interventions include: improving the knowledge and usage of quality control tools; promoting automated production systems; the adoption of just-in-time (JIT) philosophy; the application of information communication technology (ICT), and transportation and logistics management planning. In terms of competency: building inspectors specialising in prefabricated construction; prefabrication courses and training programmes; industry workshops and conferences, and on-the-job training for industry practitioners. General interventions include: more client-focused market research; financial support from government, and standardisation in terms of procurement, manufacturing, on-site installation, and inspection.

3. RESEARCH

3.1 Method and Sample Strata

Due to the nature of the data required the quantitative method was adopted.

The questionnaire was evolved based upon a survey of the literature and consisted of five sections: A: demographic information of the respondents; B: the level of exposure and experience respondents had relative to prefabrication; C: drivers of the implementation of prefabrication; D: constraints to the implementation of prefabrication, and E: factors that could potentially reduce resistance to prefabrication, and concurrence with general statements relative to prefabrication.

The researcher distributed the questionnaire via personalised emails to the selected sample. A covering letter, introducing the researcher and stating both the aim of the study and the importance of the respondents' participation accompanied the questionnaire. The respondents were given three options to respond, to maximise the response rate and improve the validity of the findings:

- Follow the link to the online survey;
- Print the attached questionnaire and scan the response back to the researcher, or
- Print the attached questionnaire and request the researcher to collect the response.

Follow up emails were sent two weeks after the initial email if no response was received. There was initially a low response rate, which was overcome through administering hardcopy versions of the questionnaire.

Initially, personalised e-mails were distributed to a combination of 36 individuals and firms from the sample. Of the 36 emails sent, five did not reach the intended recipients and were returned to sender. Only 19 of the 31 respondents commenced the online survey and of the 19, eight participants discontinued and 11 respondents completed the survey. This resulted in an initial response rate of 35.5%.

The initial number of responses from the online survey was deemed too low. Consequently, the researcher resorted to distributing additional surveys in hardcopy format. Fifteen hardcopy survey questionnaires were distributed; two were returned blank, four were not returned, and nine valid responses were secured. Therefore, the number of combined valid responses was 20, which represents an overall response rate of 43.5%. Table 1 summarises the sample size and response rate.

Table 1: Sample size and response rate

Net sample size (No.)	Valid responses (No.)	Valid response rate (%)
46	20	43.5

The data was captured and analysed in MS Excel, and descriptive statistics in the form of frequencies and a measure of central tendency, a mean score (MS), were computed. The MS was necessary to assess the degree of respondents' concurrence to five-point Likert scale questions.

3.2 Results

In terms of years experience in the industry, 35.0% had > 1 ≤ 5 years, 25.0% > 5 ≤ 10 years, 20.0% > 10 ≤ 20 years, and 20.0% > 20 years. In summary 65.0% had > 5 years, and 40.0% > 10 years.

Honours degree (65.0%) predominated in terms of qualification, followed by bachelors degree (15.0%), national diploma (10.0%), and masters degree (10.0%).

In terms of the role of respondents in the industry, general contractors accounted for 38.0%, followed by quantity surveyors (QSs) (23.0%), architects (12.0%), engineers (12.0%), construction project managers (CPMs) (8.0%) and property developers (8.0%).

The private sector (60.0%) predominated in terms of the sector respondents operated in. The public sector was only identified by 5.0%, and both sectors by 35.0%.

In terms of the type of construction projects respondents were involved in, commercial (36.0%) and residential (34.0%) featured the most, followed by industrial (22.0%), and infrastructure (7.0%).

In terms of experience with prefabrication, 45.0% of respondents indicated they had a moderate level, 45.0% a low level, and 10.0% had no experience. In terms of respondents' organisations on-site and off-site work mix, on-site work constituted 67.2%, and off-site work, 32.8%.

Table 2 indicates the different types of prefabrication respondents have used in the industry. Precast concrete slabs, precast concrete panels, steel framed construction, and aluminium frames, predominated, having been identified by ≥ 70.0% of respondents. Timber framed systems, steel panels, foundation systems, and timber panels were identified by ≥ 20.0% ≤ 30.0%. Building services, and plastic / polymer-based frames were each identified by 10.0% of the respondents.

Table 2: Types of prefabrication respondents have used in the industry

Type	%	Rank
Precast concrete slabs	85.0	1
Precast concrete panels	75.0	2
Steel framed construction	70.0	3=
Aluminium frames	70.0	3=
Timber framed systems	30.0	5
Steel panels	25.0	6
Foundation systems	20.0	7=
Timber panels	20.0	7=
Building services	10.0	9=
Plastic / polymer-based frames	10.0	9=
Other	5.0	11

Respondents were requested to indicate their level of satisfaction with prefabrication relative to a scale of 1 (very disappointed) to 5 (very satisfied). Given that the resultant MS is 2.90, which is > 2.60 ≤ 3.40, the level of satisfaction can be deemed to be disappointed to neutral / neutral.

In terms of the impact of prefabrication, 84% of respondents indicated that the introduction of prefabrication had had a positive impact on the construction schedule – 26.0% indicated it had reduced the project schedule by one week, 16.0% by two weeks, 11.0% by three weeks, and 5.0% by > 4 weeks.

In terms of the impact of prefabrication on cost, 47.0% identified a positive impact, 32.0% no impact, and 16.0% negative impact – 55.3% of the 47.0% identified a 6 – 10% decrease in cost, 34.0% a 1 – 5% decrease, and 10.0 % were unsure.

In terms of the impact on health, safety and wellbeing, 40.0% identified a positive impact, 50.0% no impact, and 10.0% a negative impact.

In terms of the impact on quality, 80.0% identified a positive impact, 15.0% a negative impact, and 5.0% were unsure.

Table 3 presents the respondents' degree of concurrence with respect to the benefits of prefabrication in terms of percentage responses to a scale of strongly disagree to strongly agree and a MS between 1.00 and 5.00. The concurrence is not ranked as it is relative to differing statements and not variables. It should be noted that the statements are positively stated in terms of the benefit based upon the findings of the literature survey, and therefore, the concurrence should be greater than 3.00. It is notable that 10 / 18 (55.6%) MSs are > 3.00, which indicates agreement, as opposed to disagreement as in the case of MSs ≤ 3.00. Furthermore, in terms of ranges, 10 / 18 (55.6%) MSs are > 3.00 ≤ 4.00, which constitutes a low level of agreement, and 8 / 18 (44.4%) of MSs are > 2.00 ≤ 3.00, which constitutes a low level of disagreement.

Included in the low level of agreement are: enhances predictability of project quality; reduces overall project duration, time spent on site, defects and snagging, construction costs, and the need for on-site problem solving; improves project quality; alleviates problems with workmanship on site; ensures project cost certainty, and certainty of project completion date.

Included in the low level of disagreement are: reduces the environmental impact of construction, reduces non-construction costs, and reduces overall life cycle costs; leads to a reduction in HSW hazards and risks; increases overall project value, and provides a greater return on investment.

Table 3: Respondents' degree of concurrence with respect to the benefits of prefabrication

Statement	Response (%)						MS
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Prefabrication enhances predictability of project quality	0.0	0.0	0.0	15.0	80.0	5.0	3.90
Prefabrication reduces overall project duration	0.0	0.0	5.0	35.0	30.0	30.0	3.85
Prefabrication reduces time spent on site	0.0	0.0	10.0	30.0	30.0	30.0	3.80
Prefabrication improves project quality	0.0	5.0	0.5	30.0	50.0	15.0	3.70
Prefabrication alleviates problems with workmanship on site	5.0	0.0	15.0	20.0	40.0	20.0	3.68
Prefabrication ensures project cost certainty	5.0	0.0	0.0	50.0	35.0	10.0	3.58
Prefabrication reduces defects and snagging	0.0	5.0	10.0	30.0	35.0	20.0	3.55
Prefabrication ensures certainty of project completion date	0.0	5.0	25.0	25.0	35.0	10.0	3.20
Prefabrication reduces construction costs	5.0	10.0	20.0	20.0	35.0	10.0	3.16
Prefabrication reduces the need for on-site problem solving	0.0	5.0	20.0	40.0	25.0	10.0	3.15
Prefabrication reduces the environmental impact of construction	5.0	35.0	40.0	35.0	15.0	5.0	2.89
Prefabrication reduces non-construction costs	5.0	10.0	20.0	35.0	30.0	0.0	2.89
Prefabrication leads to a reduction in HSW risks	0.0	25.0	5.0	40.0	20.0	10.0	2.85
Prefabrication leads to a reduction in HSW hazards	0.0	25.0	10.0	40.0	10.0	15.0	2.80
Prefabrication reduces overall life cycle costs	5.0	10.0	25.0	45.0	15.0	0.0	2.68
Prefabrication improves project HSW performance	0.0	25.0	10.0	45.0	15.0	5.0	2.65
Prefabrication increases overall project value	0.0	10.0	35.0	45.0	10.0	0.0	2.55
Prefabrication provides a greater return on investment	35.0	10.0	15.0	35.0	5.0	0.0	2.54

Table 4 presents the respondents' degree of concurrence with respect to the constraints of prefabrication in terms of percentage responses to a scale of strongly disagree to strongly agree and a MS between 1.00 and 5.00. It should be noted that the statements are negatively stated in terms of the constraints, based upon the findings of the literature survey, and therefore, the concurrence, ideally, should be ≤ 3.00, which indicates disagreement, as opposed to agreement as in the case of MSs > 3.00. It is notable that 19 / 24 (79.4%) MSs are > 3.00, which indicates agreement, as opposed to disagreement as in the case of 5 / 24 (20.6%) MSs ≤ 3.00. Furthermore, in terms of ranges, 3 / 24 (12.5%) MSs are > 4.00 ≤ 5.00, which indicates a high level of agreement, 16 / 24 (66.7%) MSs are > 3.00 ≤ 4.00, which constitutes a low level of agreement, and 5 / 24 (20.8%) of MSs are > 2.00 ≤ 3.00, which constitutes a low level of disagreement.

Included in the high level of agreement are: prefabrication reduces the ability to change designs; early constructability information is required, and prefabrication introduces increased upfront capital costs.

Included in the low level of agreement (negative aspects) are: prefabrication increases transportation cost, onsite lifting capacity, lead time of materials, design fees, and weight and size of prefabricated elements; results complex interfacing between systems is difficult to resolve; limited choice of prefabrication suppliers; limited time to cost prefabrication options; lack of prefabrication manufacturing skills; lack of guidance and information on prefabrication options; limited experience with prefabrication; restricted site layout or space; limited manufacturing capacity of suppliers; limited manufacturing time for prefabrication components, and limited codes and standards are available for prefabrication. Included in the low level of disagreement (positive aspects) are: it is difficult to achieve the required economies of scale; prefabrication reduces the environmental impact of construction, non-construction costs, and reduces overall life cycle costs, and prefabrication leads to a reduction in HSW hazards and risks, increases overall project value, and provides a greater return on investment.

Table 4: Respondents' degree of concurrence with respect to the constraints of prefabrication

Statement	Response (%)						MS
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Prefabrication reduces the ability to change designs	5.0	0.0	0.0	5.0	35.0	55.0	4.53
Early constructability information is required	0.0	0.0	0.0	10.0	35.0	55.0	4.45
Prefabrication introduces increased upfront capital costs	0.0	0.0	0.0	10.0	60.0	30.0	4.20
Prefabrication increases transportation costs	0.0	0.0	5.0	25.0	50.0	20.0	3.85
Complex interfacing between systems is difficult to resolve	0.0	0.0	5.0	30.0	40.0	25.0	3.85
Increased onsite lifting capacity	0.0	0.0	0.0	45.0	40.0	15.0	3.70
Increased lead time of materials	5.0	0.0	10.0	30.0	40.0	15.0	3.63
Limited choice of prefabrication suppliers	5.0	0.0	15.0	25.0	35.0	20.0	3.63
Prefabrication results in increased design fees	0.0	0.0	0.0	45.0	50.0	5.0	3.60
Limited time to cost prefabrication options	10.0	0.0	0.0	55.0	25.0	10.0	3.50
Lack of prefabrication manufacturing skills	5.0	0.0	5.0	50.0	35.0	5.0	3.42
Increased weight and size of prefabricated elements	0.0	5.0	5.0	50.0	25.0	15.0	3.40
Lack of guidance and information on prefabrication options	15.0	5.0	15.0	25.0	25.0	15.0	3.35
Limited experience with prefabrication	0.0	0.0	15.0	45.0	35.0	5.0	3.30
Restricted site layout or space	0.0	5.0	10.0	40.0	40.0	5.0	3.30
Limited manufacturing capacity of suppliers	15.0	0.0	10.0	45.0	30.0	0.0	3.24
Limited manufacturing time for prefabrication components	5.0	0.0	15.0	50.0	30.0	0.0	3.16
Limited codes and standards are available for prefabrication	15.0	0.0	15.0	55.0	5.0	10.0	3.12
It is difficult to achieve the required economies of scale	20.0	0.0	10.0	55.0	15.0	0.0	3.06
Limited supply time for prefabricated elements	0.0	0.0	20.0	60.0	20.0	0.0	3.00
Difficult to get full project team commitment	0.0	15.0	20.0	20.0	40.0	5.0	3.00
Inadequate management and control of supply chain	15.0	0.0	30.0	40.0	15.0	0.0	2.82
Client resistance	0.0	25.0	25.0	15.0	25.0	10.0	2.70
Difficulty in synchronising onsite and offsite schedules	5.0	40.0	45.0	5.0	5.0	5.0	2.68

Despite the low levels of prefabrication usage, 55.0% of respondents planned to increase usage of prefabrication, 35.0% indicating an increase of 6.0% - 10.0%, and 45.0% an increase of 6% - 15%. However, it is notable that 35.0% were unsure. None of the respondents expected to decrease their use of prefabrication.

Table 5 presents the respondents' degree of concurrence with respect to interventions to reduce resistance to prefabrication in terms of percentage responses to a scale of strongly disagree to strongly agree and a MS between 1.00 and 5.00. It is notable that all the MSs are > 3.00, which indicates agreement, as opposed to disagreement.

Furthermore, in terms of ranges, only 1 / 5 (20.0%) MSs is > 4.00 ≤ 5.00, which indicates a high level of agreement - price reductions.

Thereafter, 4 / 5 (80.0%) MSs are > 3.00 ≤ 4.00, which constitutes a low level of agreement - provision of examples / case studies, positive client experiences, increased marketing and information, and increased partnership arrangements.

Table 5: Respondents' degree of concurrence with respect to interventions to reduce resistance to prefabrication

Intervention	Response (%)						MS
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Price reductions	0.0	5.9	5.9	14.3	29.4	47.1	4.06
Provision of examples / case studies	0.0	0.0	0.0	14.3	11.8	41.2	3.94
Positive client experiences	0.0	5.9	5.9	30.8	70.6	11.8	3.76
Increased marketing and information	0.0	0.0	17.6	15.4	64.7	0.0	3.47
Increased partnership arrangements	0.0	0.0	23.5	42.9	47.1	5.9	3.35

Table 6: Respondents' degree of concurrence with respect to ten general statements regarding prefabrication.

Statement	Response (%)						MS
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Prefabrication must be promoted by designers	0.0	0.0	0.0	35.7	35.3	41.2	4.18
Usage of prefabrication should increase	0.0	0.0	5.9	29.4	5.9	58.8	4.18
Prefabrication reduces overall project risk	0.0	5.9	0.0	50.0	35.3	35.3	3.94
Prefabrication requires advanced manufacturing capacity	0.0	0.0	0.0	21.4	35.3	23.5	3.82
Prefabrication is not suited to low volume construction work	0.0	0.0	17.6	35.7	47.1	11.8	3.53
Expectations are too high for prefabrication	0.0	0.0	23.5	14.3	41.2	5.9	3.29
There is a negative perception with regards to prefabrication	0.0	0.0	17.6	29.6	23.5	11.8	3.29
Benefits of prefabrication are not communicated properly to owners / clients	0.0	0.0	17.6	35.7	29.4	5.9	3.24
There is a misconception that off-site / prefabrication is only suited to temporary or low-income construction	0.0	11.8	23.5	28.6	23.5	11.8	3.00
Data available for manufacturers and owners does not support decision making with a high level of confidence	5.9	5.9	11.8	0.0	17.6	0.0	2.76

Table 6 presents the respondents' degree of concurrence with respect to ten general statements regarding prefabrication in terms of percentage responses to a scale of strongly disagree to strongly agree, and a MS between 1.00 and 5.00. It is notable that 8 / 10 (80.0%) MSs are > 3.00, which indicates agreement, as opposed to disagreement, as in the case of MSs ≤ 3.00.

In terms of ranges, only 2 / 5 (80.0%) MSs are > 4.00 ≤ 5.00, which indicates a high level of agreement - prefabrication must be promoted by designers, and usage of prefabrication should increase.

Thereafter, 6 / 10 (60.0%) MSs are > 3.00 ≤ 4.00, which constitutes a low level of agreement - prefabrication reduces overall project risk, prefabrication requires advanced manufacturing capacity, prefabrication is not suited to low volume construction work, expectations are too high for prefabrication, there is a negative perception with regards to prefabrication, benefits of prefabrication are not communicated properly to owners / clients.

Lastly, 2 / 10 (20.0%) MSs are > 2.00 ≤ 3.00, which constitutes a low level of disagreement -there is a misconception that off-site / prefabrication is only suited to temporary or low-income construction, and data available for manufacturers and owners does not support decision making with a high level of confidence. It should be noted that the former has a MS of 3.00, which is the upper point of the MS range.

3 DISCUSSION

The benefits of prefabrication in terms of the empirical findings are primarily relative to quality, schedule, and cost, however, also relative to the environment and HSW, albeit to a lesser extent, which findings are reflected in the literature (Aigbavboa et al., 2018; Baghchesaraei et al., 2015; Rocha et al., 2023; Khahro et al., 2019).

There are a range of constraints relative to prefabrication as per the degree of concurrence with respect to 19 of 24 constraints, which are reflected in the literature (Baghchesaraei et al., 2015; Zhang et al., 2022; Rocha et al., 2023). However, limitation of design changes, the need for early constructability information, and increased upfront capital costs predominate in terms of the empirical findings.

The degree of concurrence with respect to interventions to reduce resistance to prefabrication indicates that there is potential for and a need for increased prefabrication, which is reflected in the literature (Baghchesaraei et al., 2015). In terms of the empirical findings, reduced cost, provision of examples / case studies, and positive client experiences predominate. However, other interventions include increased marketing and information, and increased partnership arrangements predominate, which indicates a general need for awareness, information, and a multi-stakeholder approach. These empirical findings were identified in the literature by Zhang et al. (2022).

The degree of concurrence with respect to ten general statements regarding prefabrication amplifies the need for an increase in prefabrication due to its role in reducing risk due its role in reducing variability, and for advanced manufacturing capacity. However, designers need to promote it. These empirical findings are identifiable in the literature courtesy of Baghchesaraei et al. (2015) and Zhang et al. (2022).

4 CONCLUSIONS

Limitations of the study include the sample size and a single metropole in terms of the geographical sample frame, and therefore the findings can be deemed indicative as opposed to representative.

Given that 45.0% of respondents had a moderate level of experience with prefabrication, and 45.0% a low level, it can be concluded that prefabrication is not pervasive. This conclusion is reinforced by the finding that respondents' organisations' on-site work constituted 67.2%, and off-site work, 32.8%. Furthermore, only four types of prefabrication were identified by > 30.0% of respondents in terms of use, namely precast concrete slabs, precast concrete panels, steel framed construction, and aluminium frames, which were identified by 85.0% to 70.0% of respondents.

Given that 55.0% of respondents planned to increase usage of prefabrication in the near future, it can be concluded that there is an 'appetite' for prefabrication. However, such increased usage is dependent upon the availability of prefabricated systems and elements, designers' willingness to adopt them, and designers' willingness to engender prefabrication through design.

The degree of concurrence relative to certain aspects pertaining to the benefits of prefabrication leads to the conclusion that there is a valid case therefore, especially with respect to quality, but also schedule, on site work, and cost. Furthermore, the environment and HSW constitute a case for prefabrication, albeit to a lesser extent.

The degree of concurrence relative to constraints pertaining to prefabrication leads to the conclusion that there are challenges in terms of the adoption of prefabricated systems and elements. The constraints are centred on design, standards and codes, costs, manufacturing capacity, skills, experience, and transporting, storage, and handling.

Given the degree of concurrence with respect to interventions to reduce resistance to prefabrication, it can be concluded that the challenges are not insurmountable, the required focus being relative to reducing the cost of prefabrication, the need for information, case studies, and promotion of prefabrication.

The degree of concurrence with respect to ten general statements regarding prefabrication leads to the conclusion that the there is potential to increase prefabrication due to the resulting benefits, however, negative perceptions and misconceptions exist, which can be addressed by availing project stakeholders with information and data.

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RECOMMENDATIONS

In terms of a framework of interventions to engender increased adoption of prefabrication, five categories of interventions are presented below.

Information: conducting case studies and documenting the findings thereof; professional association practice notes; development of industry standards and lobbying of financial institutions.

Awareness: exhibitions; lobbying of financial institutions, and market research.

Design: Consideration of the inclusion of prefabrication in projects, of transportation and lifting requirements, and integration of prefabrication with insitu work.

Competency: inclusion of prefabrication in all tertiary built environment education, and prefabrication continuing professional development (CPD).

Manufacturers: research and development; standardisation; enhanced application of ICT; advanced automation systems; implementation of quality management systems, and adoption of JIT.

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